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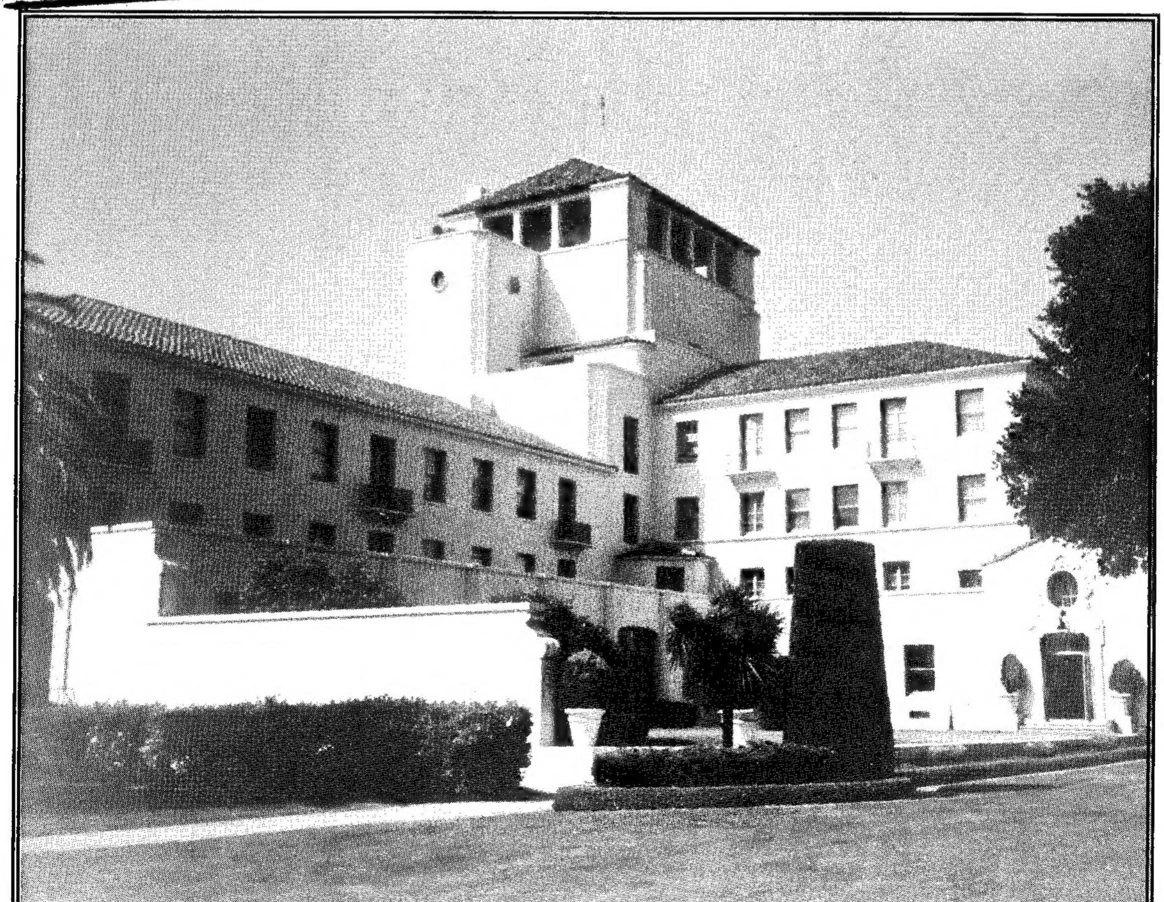
Monterey, California 93943-5138

COMPILATION OF ABSTRACTS OF THESES SUBMITTED BY CANDIDATES FOR DEGREES

OCTOBER 1993 TO SEPTEMBER 1994



NAVAL POSTGRADUATE SCHOOL
Monterey, California 93943-5000

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Monterey, California

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THE ANALYSIS WAKE-INDUCED UNSTEADY AERODYNAMICS AS RELATED TO HIGHER HARMONIC CONTROL

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B.S., Military Technical College, Cairo, Egypt, 1978
M.S.C.E., Faculty of Engineering, Zagzeg University, 1988
Doctor of Philosophy in Aeronautics and Astronautics-December 1993
Advisor: E. Robert Wood-Department of Aeronautics and Astronautics

Performance data from the NASA-Army OH-6A higher harmonic control (HHC) flight test program showed significant reductions in main rotor shaft torque and engine power in hover and forward flight [1]. The unsteady aerodynamics with the higher harmonic control system application, including wake effects, were considered to study whether such power reductions are feasible. An airfoil oscillating in pure plunge can achieve propulsive force ("Katzmayr effect"), as in the case of birds' wings flapping in flight. Here it will be shown that this effect can be enhanced in the presence of layers of shed vorticity with the proper phasing. In addition, while it is known that an airfoil oscillating in pitch, will typically produce drag at most values of reduced frequency, it is found that the presence of another layer of shed vorticity of the proper phase, can reduce the drag on the pitching airfoil and depending upon wake spacing, reduced frequency, and phase. Under some conditions the added layer or layers of shed vorticity will even result in propulsive force acting on the pitching airfoil similar to the "Katzmayr" effect for the plunging case. It was found, for the OH-6A helicopter, that the measured reductions in main rotor shaft torque and engine power are feasible when evaluated with respect to the "Katzmayr effect" and the additional drag reduction or propulsive force obtained due to pitch and plunge oscillations with the effect of adjacent wake layers of shed vorticity.

A MODEL AND ALGORITHMS FOR A SOFTWARE EVOLUTION CONTROL SYSTEM

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M.S.C.E., Faculty of Engineering, Cairo University, 1988
Doctor of Philosophy in Computer Science-December 1993
Advisor: Valdis Berzins-Department of Computer Science

This dissertation introduces an Evolution Control System (ECS) for the Computer Aided Prototyping System CAPS. The purpose of the ECS is to automate the scheduling and the assignment of tasks to the software designers based on management policies and the dependencies in a model of the software configuration. The ECS controls the software evolution process in an incrementally evolving software system where the steps to be scheduled are only partially known. Time required, the set of sub-tasks for each step, and the input/output constraints between steps are all uncertain, and are all subject to change as evolution steps are carried out. The ECS provides computer assistance for managing such changes and partially automates the control of the design team and the project data. The ECS manages both the development/prototyping data and the design team through scheduling the software tasks and assigning them to members of the design team. The main goals of this system are: 1. Managing the evolution steps from the moment they are proposed until their completion. 2. Reaching a feasible schedule that meets the deadline requirements or minimizes the largest amount that a deadline is missed if all deadlines cannot be met and provides for the earliest possible completion for those steps that either do not have deadlines or have under-estimated deadlines. 3. Maximizing the efforts of software designers by maximizing concurrent assignments. 4. Supporting incremental replanning as additional information becomes available. 5. Minimizing wasted design effort due to schedule reorganization as well as workers forced to wait for completion of sub-tasks. 6. Insuring system integrity via propagation of change consequences (induced steps) to maintain the global consistency of the database and providing serializability of updates. 7. Efficient use of space and time for the design database and scheduling algorithm, 8. Automating the process of determining which versions of the subcomponents belong to each version of the entire system. 9. Providing computer assistance for task decomposition during planning using decomposition and dependency information of the previous version of the software system. The proposed ECS system represents a management layer between the user interface (supporting two user classes, managers and designers) and the design database which contains a record of the versions of all software objects and planned, active and completed evolution steps.

THE DIURNAL CYCLE OF HIGH-FREQUENCY TEMPERATURE VARIABILITY AT 0^0, 140^0 W ON SEASONAL AND INTERANNUAL TIME SCALES

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B.S., Texas A&M University, 1981
M.S., Naval Postgraduate School, 1986
Doctor of Philosophy in Physical Oceanography
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The diurnal cycle of high-frequency temperature fluctuations attributable to turbulence and internal waves in the upper central equatorial Pacific Ocean is found to persist over most of the period November 1983 - October 1987. Moored temperature and velocity data in the upper 300 m at 0^0, 140^0W during this four-year period were used to: 1) determine the vertical extent of the diurnal cycle of turbulence and internal waves and evaluate its contribution to the equatorial zonal momentum balance, and 2) determine whether the diurnal cycle of turbulence and internal waves varied seasonally and interannually in response to varying surface forcing and ambient stability conditions. Using 15-minute spot-sampled temperature data at 35 m, 60 m, 100 m, 140 m, 200 m, and 300 m, isotherm displacement variance (IDV) was computed for each six-hour time period as a proxy for vertical overturning and displacement associated with turbulence and internal waves. The time series of monthly mean IDV for each of the six-hour time bins showed the magnitude of the diurnal cycle of turbulence and internal waves (ΔIDV) as a function of season and depth. The diurnal change in IDV was pronounced at both the 35-m and the 60-m depths, with nighttime IDV significantly greater than daytime IDV. This result is consistent with TROPIC HEAT microstructure observations over two periods of a few days to weeks, showing that IDV is a useful proxy for turbulence and internal wave energy during periods when microstructure measurements are not available. The magnitude of ΔIDV decayed sharply with depth below 60 m, indicating that little diurnally-modulated internal gravity wave energy had propagated down through the equatorial undercurrent core. Hence, internal wave propagation does not appear to be important for loss of zonal momentum to the regions below the core of the undercurrent. Monthly means of both IDV and ΔIDV at 35 m and 60 m suggest that turbulence and internal waves varied over seasonal and interannual time scales. Seasonally, maxima of IDV and ΔIDV occurred during the boreal winter, when wind speed and mixed-layer depth were at their annual maxima and shortwave radiation was at its annual minimum. Minima of IDV and ΔIDV occurred during the boreal spring, when wind speed and mixed-layer depth were at their annual maxima and shortwave radiation was at its annual maximum. Over the 48-month period of study, ΔIDV at 35 m and 60 m were significantly correlated with wind speed, zonal wind, mixed-layer depth, diurnal range of mixed-layer depth, buoyancy frequency, and shortwave radiation. The strong correlations are consistent with the use of IDV as a proxy for turbulence-wave processes associated with shear production and buoyancy flux in the marginally stable entrainment zone between the surface well-mixed layer and the undercurrent core.

TIDAL DYNAMICS AND MIXING OVER STEEP TOPOGRAPHY

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M.S., Physical Oceanography, Naval Postgraduate School, 1991
Doctor of Philosophy in Physical Oceanography-June 1994
Advisor: Timothy P. Stanton-Department of Oceanography

Coastal currents and water column stratification frequently are determined by local phenomena that interact to produce complex dynamics. A process study was designed to assess the role of tides over a coastal shelf break as a local source of internal waves spatially-inhomogeneous, baroclinic residual currents, and internal mixing. The temporal evolution of three dimensional stratification and currents were characterized within a 4Kmx4Km box close to the mouth of Monterey Canyon, California. Strong, baroclinic, unidirectional, spatially inhomogeneous jet-like currents were observed with 24 hours periods, together with the occurrence of semidiurnal thermocline oscillations and vertically mixed layers. Linear theory of Baines (1982) predicts the existence of significant tidally forced internal waves in the area, with an interfacial mode at the thermocline decoupled from the internal waves propagating in the weaker stratification below. A ray tracing method is developed to study the nonlinear propagation of these tidally forced internal waves by considering wave advection and straining by the topographically controlled barotropic tidal flow while neglecting internal wave-wave interactions. It is found that nonlinear interaction of tidally forced internal waves with the topographically controlled barotropic tidal flow is a mechanism capable of forcing residual currents and internal wave shear instabilities that are capable of creating internal mixed layers similar to those observed at the mouth of Monterey Canyon.

A FORMAL METHOD FOR SEMANTICS-BASED CHANGE-MERGING OF SOFTWARE PROTOTYPES

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M.S., Naval Postgraduate School, 1990
Doctor of Philosophy in Computer Science-June 1994
Advisor: Valdis Berzins-Department of Computer Science

This dissertation addresses the need for a formal method to support the merging of changes in independently developed versions of a prototype in a computer-aided rapid prototyping system. The goal is to provide the prototype developer with the ability to: combine independently developed enhancements to a prototype, check for consistency, and automatically update all derived versions of a prototype with changes made to the base version. A useful semantics-based method is provided for change-merging that is guaranteed to detect all conflicts. Prototype slicing is used to capture the affected parts of each variation and the preserved part of the base in both variations. We then combine the affected parts with the preserved part using our model, which includes the first use of Brouwerian algebras to formalize the merging of hard, real-time constraints. Our Slicing Theorem guarantees that this method produces a prototype that correctly exhibits the significant behavior of each of the input versions, provided the changes do not conflict. The method achieves correctness by comparing the slice of the change-merged version with respect to each affected part against the same slice of the appropriate changed version. If the slices are the same, the change-merge is correct, otherwise a diagnostic message results. A preliminary conditional method for change-merging while programs is also provided that is strictly more accurate than previous methods. The dissertation contributes to computer-aided software maintenance by providing a model, algorithm and implementation for an automated change-merging tool for PSDL prototypes. Preliminary testing shows that this tool will enhance the ability of the prototype developer to deliver a prototype in less time by enabling more concurrency in the development effort.

COMPUTER SIMULATION OF WAVE PROPAGATION THROUGH TURBULENT MEDIA

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B.S., Duke University, 1983
M.S., Naval Postgraduate School, 1991
Doctor of Philosophy in Physics-June 1994
Advisor: Donald Walters-Department of Physics

This research used Huygens-Fresnel wave optics computer simulations to investigate the effects of high turbulence strength and inner scale on the normalized irradiance and coherence length of electromagnetic waves propagating through a turbulent atmosphere. These investigations developed several guidelines for validity of propagation simulations employing a numerical, split-step, Huygens-Fresnel, method, and within these guidelines, considered five types of turbulence spectrum inner scale: (1) zero inner scale, (2) Gaussian inner scale, (3) Hill's and (4) Frehlich's viscous-convective enhancement inner scales, and (5) turbulence spectrum truncation from the discrete grid representation. The simulation results showed that the normalized irradiance variance generally decreased (~30%) below the zero inner scale values in the Rytov regime with increasing inner scale size, but increased monotonically in the saturation regime, and agreed with 2% of the Rytov-Tatarski predictions at low turbulence strengths. The E-field coherence length in a spatially confined beam, with either spherical or plane wave divergence and zero inner scale, followed the Rytov-Tatarski-Fried predictions in the Rytov regime, but departed from the theory in the saturation regime. Increasing inner scale size modified this finite beam behavior by raising the coherence length (up to ~50%) in the saturation regime.

DOUBLE EULERIAN CYCLES ON DE BRUIJN DIGRAPHS

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M.S., Naval Postgraduate School, 1985
Doctor of Philosophy in Applied Physics-June 1994
Advisor: Harold Fredricksen-Department of Mathematics

A binary de Bruijn sequence has the property that every n-tuple is distinct on a given period of length 2^n. An efficient algorithm to generate a class of classical de Bruijn sequences is given based upon the distance between cycles within the Good - de Bruijn digraph. The de Bruijn property on binary sequences is shown to be a randomness property of the ZERO and ONE run sequences. Utilizing this randomness we find additional new structure in de Bruijn sequences. We analyze binary sequences that are not de Bruijn but instead possess the sufficient structure so that every distinct binary n-tuple can be systematically "combed" out of the sequence. These complete or nonclassical de Bruijn sequences are a generalization of the well-known de Bruijn cycle. Our investigation focuses on binary sequences, called double Eulerian cycles, that define a cycle along a graph (digraph) visiting each edge (arc) exactly twice. A new algorithm to generate a class of double Eulerian cycles on graphs and digraphs is found. Double Eulerian cycles along the binary Good - de Bruijn digraph are partitioned by the run structure of their defining sequences. This partition allows for a statistical analysis to determine the relative size of the set of complete cycles defined by the sequences we study. A measure that categorizes double Eulerian cycles along graphs (digraphs) by the distance between the two visitations of each edge (arc) is provided. An algorithm to generate double Eulerian cycles of minimum measure is given.

PLANT/CONTROLLER OPTIMIZATION BY CONVEX METHODS

Robert Jay Niewoehner, Jr.-Lieutenant Commander, United States Navy
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M.S.E.E., The Johns Hopkins University, 1981
Doctor of Philosophy in Aeronautical Engineering-June 1994
Advisor: Isaac I. Kaminer-Department of Aeronautics and Astronautics

This report presents results of a three phase effort to demonstrate the use of convex control design techniques in aeronautical applications. The first phase was the demonstration of a methodology by which classical aircraft controller design requirements could be translated into the weighting matrices for H_∞ controller synthesis. The second phase extended that methodology to the design of mixed H_2/H_∞ controllers. The third phase considered the problem of minimizing the size of aircraft control surfaces while meeting closed-loop dynamic performance requirements. Control sizing is a critical element in the design of Reduced Static Stability (RSS) aircraft. Inadequate control power places the vehicle in peril, while too much control power forfeits the benefits of RSS, resulting in poorer performance, increased weight, increased cost, increased drag, and increased observability. Non-heuristic methods have been required by which the physical configuration and the accompanying controller can be designed directly from the flying qualities specifications. The optimization of the surfaces should be done while searching over the set of all controllers which, together in closed-loop, satisfy the flying qualities requirements. This report presents a methodology which simultaneously optimizes both the physical configuration and the control system of a rigid body, using performance requirements which can be posed as Linear Matrix Inequalities.

A MULTILEVEL APPROACH TO THE ALGEBRAIC IMAGE RECONSTRUCTION PROBLEM

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B.S., U.S. Military Academy, 1976
M.S., University of Colorado, 1985
Doctor of Philosophy in Applied Mathematics, June 1994
Advisor: Van Emden Henson-Department of Mathematics

The problem of reconstructing an image from its Radon transform profiles is outlined. This problem has medical, industrial and military application. Using the computer assisted tomography (CAT) scan as an example, a discretization of the problem based on natural pixels is described, leading to a symmetric linear system that is in general smaller than that resulting from the conventional discretization. The linear algebraic properties of the system matrix are examined, and the convergence of the Gauss-Seidel iteration applied to the linear system is established. Next, multilevel technology is successfully incorporated through a multilevel projection method (PML) formulation of the problem. This results in a V-cycle algorithm, the convergence of which is established. Finally, the problem of spotlight computed tomography, where high quality reconstructions for only a portion of the image are required, is outlined. We establish the formalism necessary to apply fast adaptive composite (FAC) grids in this setting, and formulate the problem in a block Gauss-Seidel form. Numerical results and reconstructed images are presented which demonstrate the usefulness of these two multilevel approaches.

IMPACT OF PHYSICAL PROCESSES ON MARITIME FRONTOGENESIS

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B.S., San Jose State University, 1979
M.S., San Jose State University, 1981
Doctor of Philosophy in Meteorology-June 1994
Advisor: Roger T. Williams-Department of Meteorology

A hydrostatic primitive equation model initialized in a highly baroclinically unstable state was used to simulate maritime cyclogenesis and frontogenesis. In order to identify boundary layer physical processes important in maritime frontogenesis, several different simulations were performed. An adiabatic and inviscid simulation provided the control for these experiments. The two different boundary layer parameterizations used were a K-theory parameterization and a second-order closure scheme. Results indicated that strong warm and cold fronts formed in the adiabatic and inviscid case but that the near-surface wind speed and vertical motion fields were unrealistic. In the K-theory simulation, the results were somewhat more realistic but convergence and vorticity were weaker. Results from the second-order closure simulation demonstrated that turbulent mixing of momentum was most important in producing the frontogenetic (and frontolytic) effects of the transverse secondary circulation.

MASTER OF SCIENCE
IN
AERONAUTICAL ENGINEERING

INTERACTION, BURSTING AND DYNAMIC CONTROL OF VORTICES OF A CROPPED DOUBLE-DELTA WING AT HIGH ANGLE OF ATTACK

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B.S., Embry-Riddle Aeronautical University, Daytona Beach Florida, 1987
Master of Science in Aeronautical Engineering-March 1994
Advisor: Sheshagiri K. Hebbar-Department of Aeronautics and Astronautics

A flow visualization study of the vortical flow over a cropped double-delta wing model with sharp leading edges and its three derivatives with small geometric modifications (fillets) at the strake wing junction was conducted in the Naval Postgraduate School water tunnel using the dye-injection technique. The fillets increased the wing area of the baseline model by 1%. The main focus of this study was to evaluate the effect of fillets on vortex core trajectories, interactions and breakdown on the leeward surface at high angles of attack (AOA) with zero sideslip angle. Comparison of test results for different fillet shapes indicates delay in both vortex interaction and breakdown at high AOA, particularly for the diamond fillet shape. The vortex breakdown data implies lift augmentation for both static and dynamic case, with the static data correlating well with recently published numerical data.

MATCH NUMBER, FLOW ANGLE, AND LOSS MEASUREMENTS DOWNSTREAM OF A TRANSONIC FAN-BLADE CASCADE

Jeffrey Gerald Austin-Lieutenant, United States Navy
B.S., University of Puget Sound, 1985
Master of Science in Aeronautical Engineering-March 1994
Advisor: Ray P. Shreeve-Department of Aeronautics and Astronautics

Two dimensional flow measurements of Mach number and flow angle were conducted downstream of a transonic fan-blade cascade at a Mach number of 1.4 to provide baseline data for assessing the effect of vortex generating devices on the suction surface shock-boundary layer interaction. The experimental program consisted of the design and calibration of a traversing three-port pneumatic probe to measure Mach number and flow angle and initial cascade measurements to provide baseline data for the fully-mixed-out total pressure loss coefficient and flow turning angle. Similar tests are planned with the vortex generating devices installed. Comparisons with and without the vortex generating devices are needed to quantify the overall effect on the shock-boundary interaction in a transonic fan-blade passage, and to assess the potential for using vortex generating devices in military engine fans.

NPS STATE VECTOR ANALYSIS AND RELATIVE MOTION PLOTTING SOFTWARE FOR STS-51

Lee Allen Barker-Lieutenant, United States Navy
B.S., United States Naval Academy, 1984
Aeronautical and Astronautical Engineer-March 1994
Master of Science in Astronautical Engineering-March 1994
Advisor: Rudolf Panholzer-Space Systems Academic Group

This thesis outlines the objectives, structure, and operation of the software designed to meet requirements set forth by Development Test Objective 700-6 for the space shuttle Discovery mission STS-51. The primary goals were the comparison of state vector information produced by GPS sources and Discovery's inertial navigation computer, and the real-time display of relative position and rendezvous information between Discovery and a retrievable shuttle pallet satellite. In-flight and post-flight examination of GPS and inertial state vectors provided the first step in the development of GPS as an on-orbit navigation system. Analysis of the Orbiter and target satellite state vectors produced real-time graphical displays of operationally significant data to the Discovery's flight crew during rendezvous and proximity operations.

ARTIFICIAL NEURAL NETWORK MODELING OF DAMAGED AIRCRAFT

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Master of Science in Aeronautical Engineering-March 1994
Advisor: Daniel J. Collins-Department of Aeronautics and Astronautics

Aircraft design and control techniques rely on the proper modeling of the aircraft's equations of motion. Many of the variables used in these equations are aerodynamic coefficients which are obtained from scale models in wind tunnel tests. In order to model damaged aircraft, every aerodynamic coefficient must be determined for every possible damage mechanism in every flight condition. Designing a controller for a damaged aircraft is particularly burdensome because knowledge of the effect of each damage mechanism on the model is required before the controller can be designed. Also, a monitoring system must be employed to decide when and how much damage has occurred in order to re-configure the controller. Recent advances in artificial intelligence have made parallel distributed processors (artificial neural networks) feasible. Modeled on the human brain, the artificial neural network's strength lies in its ability to generalize from a given model. This thesis examines the robustness of the artificial neural network as a model for damaged aircraft.

COURSE MODULE FOR AA 2021: WING STRUCTURAL DESIGN PROJECT

Stephen A. Burris, P.E.-Lieutenant Commander, United States Navy
B.S., Mechanical Engineering, 1982
Master of Science in Aeronautical Engineering-March 1994
Advisor: Gerald H. Lindsey-Department of Aeronautics and Astronautics

This thesis defined a fundamental approach for aircraft wingbox design appropriate for an introductory course in aircraft structures based upon material strength and stiffness requirements. The process developed sought to encompass major conceptual engineering design considerations that ranged from load estimation at various points in the subsonic flight envelope, to initial structural sizing and layout. The goal was to present a process that could be readily conducted via hand calculations and applied by any student entering basic aircraft structures design. The sequence of analysis began with application of a comprehensive panel code method developed by NASA Ames Research Center known as PMARC. Loads obtained from the code were then used to formulate a strength of materials study of the structure subjected to combined bending, shear and torsion. The static load approach allowed initial estimation of component sizing based upon material or buckling allowable stress selection. Finally, the study demonstrated a strength to weight ratio comparison. Several calculation examples and computer-based spreadsheets were prepared for rapid analysis of multiple option design scenarios. Since the study employed analysis methods that could be performed without the aid of a finite element routine or extensive computer programming knowledge, it serves as a good introduction for the entry and intermediate level structural engineer.

CONSTRUCTION AND WIND TUNNEL TEST OF A 1/12TH SCALE HELICOPTER MODEL

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Master of Science in Aeronautical Engineering-September 1994
Advisor: E. Roberts Wood-Department of Aeronautics & Astronautics

This thesis reports on the construction of a 1/12th scale model of the award winning Arapaho attack helicopter design and wind tunnel test to determine both the model and full scale equivalent flat plate area. Tests were conducted for 1g level flight and included yawed flight conditions up to 10 degrees. The significance of equivalent flat plate area for helicopters is that it is the principal parameter that establishes rotor propulsive force requirements. The Model was constructed from the original design submitted by the 1993 NPS Helicopter Design Team and is 47.5 inches long with a 48-inch main rotor diameter. The model was tested in the NPS Low Speed Wind Tunnel to measure the drag force on the main body of the model at wind tunnel velocities up to 72 knots. Drag force on the model was also measured with the rotor head and longbow radome installed, and at various yaw angles up to 10 degrees. The equivalent flat plate area was then calculated from these measurements and compared to other helicopters. Recommendations for further wind tunnel testing were made.

LOW-SPEED WIND TUNNEL TESTING OF THE NPS/NASA AMES MACH 6 OPTIMIZED WAVERIDER

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Master of Science in Aeronautical Engineering-June 1994
Advisors: Conrad Newberry and J. Bowles-Department of Aeronautics and Astronautics

Low-speed wind tunnel tests were conducted to determine the subsonic aerodynamic characteristics of an optimized supersonic (Mach 6) conical-flow waverider designed for a deck-launched intercept mission. These tests are part of the continuing waverider research being conducted by the Naval Postgraduate School and the NASA Ames Research Center. The tests consisted of performing α and ß sweeps, at different dynamic pressures, with a 15 inch aluminum waverider model in the NPS low-speed wind tunnel. Force and moment data were then collected using a six-degree-of-freedom sting balance. Coefficients of lift, drag and pitch were calculated from the data and compared to theory and existing waverider subsonic aerodynamic performance data. Flow visualization using tufts was also done. The results of the experiments show that waverider exhibits high lift characteristics at positive angles of attack. The design also compares favorably with both subsonic thin airfoil theory and the results of the delta wing and subsonic waverider analysis done by Vanhoy. However, flow visualization showed that vortex bursting and flow separation occurred at a dynamic pressure of $12.1 lb_f$ attack. Based upon the data collected in this analysis, the development of an actual waverider aircraft using the NPS/NASA Ames waverider design as a baseline is a plausible endeavor.

EFFECT OF JUNCTURE FILLETS ON DOUBLE-DELTA WINGS UNDERGOING SIDESLIP AT HIGH ANGLES OF ATTACK

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B.S., Chinese Air Force Academy, 1979
Master of Science in Aeronautical Engineering-September 1994
Advisor: S.K. Hebbar-Department of Aeronautics & Astronautics

A flow visualization study of the vortical flow over a baseline double-delta wing model and a diamond fillet double-delta wing model, both with sharp leading edges, was conducted in the Naval Postgraduate School water tunnel using the dye-injection technique. The diamond fillet increased the wind area of the baseline model by 1%. The main focus of this study was to observe the effect of juncture fillet on the vortex core trajectory and vortex burst location on the wing surface at high angles of attack with sideslip angles. The data reported in this thesis is believed to be <u>the first of its kind on the effect of juncture fillets on double-delta wings undergoing sideslip at high angles of attack</u>. The results indicate that the strake vortex burst point moves upstream with increasing angle of attack at zero sideslip angle; but at constant angle of attack the windward side starke vortex burst location moves upstream and inboard while the leeward side vortex burst point moves downstream and outboard with increasing sideslip angle. Comparison of test results between the baseline model and the diamond-fillet model indicates a clear delay for the latter model in terms of both vortex core trajectory and breakdown location at high angles of attack with and without sideslip angle. The vortex breakdown data for the diamond-fillet model implies lift augmentation during sideslip motion, thus supporting the concept of flow control using fillets.

EVALUATION OF THE HAWORTH-NEWMAN AVIONICS DISPLAY READABILITY SCALE

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Master of Science in Aeronautical Engineering-September 1994
Advisor: Judith H. Lind-Department of Operations Research

This study investigates the suitability of the Haworth-Newman Display Readability Rating Scale as a performance-based test and evaluation tool. This evaluation has been necessary to determine if the scale actually measures display readability, and if consistent, reproducible results are attainable. Background information on the scale's development is presented along with a brief description of display readability characteristics. A technique for systematic degradation of display readability and a method of displaying degraded symbology sets is introduced. A flight simulation experiment was conducted to obtain performance data, Haworth-Newman readability ratings, and participants' written comments for each of the degraded symbology set levels. Five Naval test pilots attempted to main specified heading, altitude, and airspeed while utilizing the ten levels of symbology sets and then used the Haworth-Newsman scale to rate the display readability for each. Experimental results are discussed and recommendations presented.

COMBUSTION EFFICIENCY IN A DUAL-INLET SIDE-DUMP RAMJET COMBUSTOR

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A dual, axially-in-line, side dump, liquid fueled ramjet combustor was designed and tested with varying fuel-air-ratios, atomizer types, and air distributions between the two inlets. Particle size distributions produced by the atomizers were measured at the inlet duct plane. When operated in a contra-flow direction, all of the atomizers produced excellent atomization with a Sauter mean diameter less than 14 microns. The dual in-line inlets provided improved flammability limits and combustion efficiencies at lean fuel-air ratios when compared to single side-dump performance. Direct injection of approximately 20% of the fuel flow into the dome region was found to provide improved lean flammability limits for the single side-dump, but was not required with the dual inlets. The fuel distribution in the inlet duct required for good flammability limits and combustion efficiency was opposite to that required to prevent pressure oscillations, indicating that a dump plane aero-grid will often be necessary. A dump angle of 45^0 resulted in lower than desired combustion efficiencies, apparently due to poor mixing with the air form the aft inlet.

AN EXPERIMENTAL INVESTIGATION OF JET-INDUCED GROUND EFFECTS AND SUPPORT STRUT INTERFERENCE ON A STOVL CONFIGURATION IN HOVER

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A small-scale ground-effect test rig was designed and fabricated to study the ground-plane flow field generated by a STOVL aircraft in hover. The objective of the research was to support NASA Ames Research Center's planning for the upcoming large-scale powered model hover tests for the ARPA sponsored ASTOVL program. Specifically, small-scale oil-flow visualization studies were conducted to make a relative assessment of the aerodynamic interference of two proposed support-strut configurations on the ground-plane stagnation line. A simplified flat-plate model representative of a generic jet-powered STOVL aircraft with both the lift fan and the main engine simulated by air jets, with nozzle pressure ratios closely matching those of the large scale tests, was utilized. The flow visualization data clearly identified an aft shift in the stagnation line location for both strut configurations. Although the data indicated a slight reduction in the aft shift for the wider strut configuration, considering the experimental uncertainties involved it was concluded that either of the strut configurations caused only a minor aerodynamic interference.

INVESTIGATION OF SUPPORT STRUCTURE INFLUENCE ON THE FLOW FIELD NEAR THE WINGTIP OF A STOVL CONFIGURATION IN HOVER

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Acquisition phase (Concept Exploration) of the Advanced Short Takeoff/Vertical Land (ASTOVL) aircraft development includes, among other tests, evaluation of forces and moments on a large-scale powered model (LSPM) suspended in the Outdoor Aerodynamic Research Facility (OARF) at the NASA Ames Research Center. This investigation assessed the influence of the OARF support structure upon the flow field through LDV measurements in the vicinity of the struts and the wingtip of a generic flat-plate model mounted in the sub-scale NPS ground-effects test rig. The model was a twin subcritical jet configuration with the nozzles arranged in tandem. The test environment was saturation seeded using a smoke generator and LDV measurements were made in the entrained flow. Non-coincident measurements were made to determine the three component mean velocities at points in the region of interest and the component mean and composite mean velocities compared for configurations with struts present and struts removed. Variations were discernible in the component mean velocities between samples both in the same strut configuration and between the struts-installed and struts-removed configurations, but were generally small enough to be considered negligible.

WIND TUNNEL PERFORMANCE COMPARATIVE TEST RESULTS OF A CIRCULAR CYLINDER AND 50% ELLIPSE TAILBOOM FOR CIRCULATION CONTROL ANTITORQUE APPLICATIONS

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Master of Science in Aeronautical Engineering-March 1994
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A low speed wind tunnel study to quantitatively evaluate the performance (lift and drag) of a circular cylinder and comparable 50% ellipse circulation control tailboom model was conducted. Circular cylinder performance was evaluated at slot positions of 80^0 to 135^0, measured relative to freestream; 50% ellipse performance was measured for angles of attack between -5^0 and 30^0. Tests were conducted at three blowing coefficients, 0.3, 0.4 (optimal historically) and 0.5, to evaluate tailboom performance sensitivity. Circular cylinder test results revealed optimal c_l values at an approximate 116^0 slot position, corresponding to c_d values no greater than that of a smooth cylinder. The 50% ellipse results revealed optimal c_l values at approximately 18^0 AOA, though associated with considerable drag. For all three blowing coefficients, the circular cylinder L/D values were consistently three to four times greater than their 50% ellipse counterparts. Recommendations for future NOTAR™ tailboom design modifications and later research are made.

DESIGN AND EVALUATION OF A LQR CONTROLLER FOR THE BLUEBIRD UNMANNED AIR VEHICLE

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The modern aerospace controls engineer is provided with a variety of powerful tools to aid in the design and testing of digital flight control systems. The current fiscal environment requires extensive validation of all aerospace based systems through simulation and hard-in-the-loop testing prior to implementation. This work explores the design and evaluation of an Automatic Flight Control System (AFCS) for the Bluebird Unmanned Aerial Vehicle (UAV). Software tools such as MATLAB and MATRIX_X are used to evaluate the dynamic stability of the aircraft model and Linear Quadratic Gaussian algorithms are used to obtain the appropriate controller. Graphical design applications such as SIMULINK and SystemBuild are then used to build a visual block diagram model of the aircraft dynamics and link it with the designed controller. Using this model, the control system response to commanded inputs and external disturbances was evaluated.

DESIGN AND MONTE CARLO ANALYSIS OF AN UNMANNED AERIAL VEHICLE
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In the last several year, software innovations and the increasing speed and availability of microcomputers and workstations have made the dynamic simulation of complex systems more practical. One such system, a short-range Unmanned Aerial Vehicle called Bluebird, was previously modeled on Simulink, a commercial software package. The high fidelity model includes six degree of freedom nonlinear equations of motion with onboard sensors and a Global Positioning System and inertial navigation system. Because of interest expressed by the Unmanned Aerial Vehicle Joint Program Office in how accurately a UAV could identify a target's geographical coordinates, the Bluebird model, with an added guidance and control system, was evaluated as to its navigational and attitudinal accuracy in a dynamic simulation using Monte Carlo techniques. Because of the modular nature of the simulation, future evaluations of manned or unmanned aircraft and avionics will involve relatively uncomplicated changes to the existing model.

VALIDATION AND IMPLEMENTATION OF OPTICAL DIAGNOSTICS FOR PARTICLE SIZING IN ROCKET MOTORS
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Aluminum oxide ($A1_2O_3$) particles of known size distribution were cast into a solid propellant which burned at temperatures less than the melting point of $A1_2O_3$. Thus, particles of known size distribution existed at the nozzle inlet and in the plume. Malvern particle sizing instruments were used to make measurements at these two location using a windowed subscale motor and the results were compared to the known distribution. In the motor, measurements were limited due to disruptive flow from the window purge gas. However, the unaffected larger modes were properly measured. In the plume, the measurements of the modes were quite accurate, but low signal strength resulted in some inaccuracies for the mass contained in each mode. A phase Doppler particle analyzer was adapted to an existing plume probe. Initial measurements at two radial locations were in good agreement with the expected size distribution.

DESIGN OF A GPS AIDED GUIDANCE, NAVIGATION, AND CONTROL SYSTEM FOR TRAJECTORY CONTROL OF AN AIR VEHICLE
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The advent of GPS has afforded the aerospace controls engineer a powerful, new means of controlling air vehicles. This work explores a new method of designing and implementing controllers and guidance systems for autonomous control of air vehicles utilizing a GPS integrated guidance, navigation and control system. This is a subject of considerable interest when realizing controllers to track reference trajectories given in an inertial reference frame. The design, implementation, and dynamic simulation of a precise tracking trajectory controller for an Unmanned Air Vehicle (UAV) is presented. This design provides a natural conversion of commands and other measured outputs (such as GPS signals) from an inertial reference frame to a body-fixed reference frame. This achieves automatic recruiting of the actuators while preserving the properties of the original design (linearization principle).

COST EFFECTIVENESS ANALYSIS OF WINGSHIP COMBATANTS

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An analysis of the tactical and cost effectiveness of wing-in-ground-effect aircraft (wingships) used as naval surface combatants was conducted. Wingships were compared to current surface combatant warships, carrier based aircraft, and long range bomber aircraft in their projected ability to conduct cruise missile, interdiction bombardment ashore, air defense, and mine warfare missions. Wingships were found to be most effective when a rapid strategic deployment is necessary, such as a response to a regional crisis. Wingships are capable of accomplishing all four missions studies, but are environmentally limited by high sea states and periods of excessive sea loiter. Several technical risk areas are discussed, including lessons learned from Russian wingship experience. The costs of maintaining a fleet of wingships at CONUS bases was compared to the costs of maintaining surface combatant and carrier groups at sea. Projected acquisition and operating costs are higher for wingships than for the other methods, but their tactical and strategic speed advantages offer a unique combat capability.

ADAPTIVE CONTROL FOR A SPACECRAFT ROBOTIC MANIPULATOR

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This research involves the development of an adaptive control law for a space based two-link robotic manipulator. Non-adaptive controllers are first obtained utilizing feedback linearization techniques. A direct adaptive controller is then developed through the linear parameterization of the system dynamics, and the implementation of a Kalman Filter based adaption law. The controllers are then simulated and compared for various levels of system parameter uncertainty. The adaptive controller is found to be superior to the non-adaptive controllers for high levels of system parameter uncertainty. The non-adaptive controller is found to compare favorably to the adaptive controller in some areas for low values of system parameter uncertainty. The non-adaptive controller is implemented experimentally, consistent with hardware constraints. Experimental results verify the need for adaptive control when system dynamics are present which have not been modelled.

HYDRODYNAMIC OF FLOWFIELD VISUALIZATION STUDIES OF A MACH 6 WAVERIDER

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Flowfield visualization studies of a conical flow derived waverider were conducted in the Naval Postgraduate School water tunnel facility, as part of an ongoing effort by the Naval Postgraduate School and the NASA Ames Research Center. The model, with an 8 inch root chord, 7.5 inch span and an aspect ratio of 1.41, was designed and constructed with an integrated forebody engine inlet ramp system and cowling for a hydrocarbon scramjet type propulsion system. Still photographs and video frames were taken for pitch angles between 0^0 and 20^0 and yaw angles between 0^0 and 10^0. The waverider vortical flowfield was similar to that associated with sharp leading edge delta wings with the primary vortex separating at the leading edge and rolling up over the upper surface. However, a comparison of waverider with delta wing data suggests that vortex core breakdown occurred at much lower angles of attack on the blunt nosed (planform) waverider.

AN APPLICATION OF VIRTUAL PROTOTYPING TO THE FLIGHT TEST AND EVALUATION OF AN UNMANNED AIR VEHICLE

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Virtual Prototyping is an integral part of the ongoing effort to design, test and fly an Unmanned Air Vehicle. Current analytical software such as SIMULINK or MATRIXx provide powerful design tools with limited graphical output, that require an intimate knowledge of the underlying dynamic structure. For comprehension, Virtual Prototyping allows an intuitive approach toward understanding the dynamic performance of the model. When the aircraft is flown within visual range of the ground station, a Virtual Prototype display provides the pilot on the ground a close-up view of aircraft response. When the aircraft operates over the horizon, a Virtual Prototype display becomes the only visual link between the pilot and the aircraft. An application of a Virtual Prototype software is presented here with a direct view to implementing the results in the UAV project currently underway at the Naval Postgraduate School.

PRELIMINARY PANSAT GROUND STATION SOFTWARE DESIGN AND USE OF AN EXPERT SYSTEM TO ANALYZE TELEMETRY

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The Petite Amateur Navy Satellite (PANSAT) is a digital communications satellite to be used by civilian amateur radio operators. The master ground station at the Naval Postgraduate School performs satellite commands, displays telemetry, trouble-shoots problems, passes messages, and controls an open loop tracking antenna. This paper concentrates on the telemetry subsystem, and interpretation with an Expert System. When commanding the satellite, the ground station software will verify the instruction with a ground-based simulator before it is sent to the satellite. Telemetry is displayed in an easily interpretable format, so that any user can understand the current health of the satellite and be cued to any problems and possible solutions. Only the master ground station has the ability to receive all telemetry and send commands to the spacecraft; civilian ham users do not have access to this information. The telemetry data is decommutated and analyzed before it is displayed to the user, so that the raw data will not have to be interpreted by ground users. The analysis will use C Language Integrated Production System (CLIPS) imbedded in the code, and derive its inputs from telemetry decommutation. The program is an expert system using a forward chaining set of rules based on the expected operation and parameters of the satellite. By building the rules early in construction and design satellite, the telemetry can be well understood and interpreted after the satellite is launched and the designer may no longer be available to provide input to the problem.

CYLINDER DRAG EXPERIMENT - AN UPGRADED LABORATORY

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A generalized automated data acquisition system was designed for the Naval Postgraduate School Low speed Wind tunnel. A specific application of this system was to upgrade the current "Cylinder Drag Experiment" conducted during AA2801 "Aero Laboratories I", an introductory aeronautical laboratory course taught at the Naval Postgraduate School. Two methods of drag determination were used: pressure distribution and wake analysis (momentum method). Data from these two methods were collected by a system based on a high speed analog/digital computer board, a standard 486 IBM-type PC and data acquisition software. Characteristic methods of reducing data from this experiment are discussed. The results obtained by analyzing the acquired data compared favorably to empirical data from previous circular cylinder coefficient of drag experiments. This automated data acquisition system will facilitate future research and instructional use of the wind tunnel.

AUTOMATION OF HARDWARE-IN-THE-LOOP TESTING
OF CONTROL SYSTEMS FOR UNMANNED AIR VEHICLES

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Modern computing advances allow the aerospace controls engineer the ability to design, test, and implement automatic control systems for air vehicles with breath taking speed and accuracy. This work examines the automation of the hardware-in-the-loop testing and implementation of autonomous controllers for Unmanned Air Vehicles. Extraordinary interest is generated in this subject considering automation results in hardware-in-the-loop testing within days of completing a controller design. the entire automation process is presented, from design of the controller to implementation on a particular control platform to hardware-in-the-loop testing of the controller. This accomplishes control design and implementation in a matter of months compared to a few years or more before automation.

NUMERICAL OPTIMIZATION OF SYNERGETIC MANEUVERS

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The use of atmospheric forces to produce an orbital plane change requires less energy than a pure exoatmospheric propulsion maneuver. The combination of aerodynamic and propulsive forces to cause a change in orbital inclination is termed a synergetic maneuver. Several methods have been proposed to control the critical heating rate while performing the procedure. This thesis examines these control methods by numerically optimizing the trajectory for several fuel weights and heat rate constraints. The Program Optimize Simulated Trajectories (POST) is used to simulate the maneuvers and control schemes, and to perform the optimization. For no active heat constraints, it is shown that a gliding atmospheric entry followed by a maximum throttle "bang" produces significantly more inclination change than other proposed maneuvers. If the heat constraints are active, the recently proposed aerobang maneuver produces a substantial inclination change while providing significant heating rate control and shows definite advantages over the long-studied aerocruise maneuver.

PROBABILISTIC RELIABILITY MODELING OF FATIGUE ON THE H-46 TIE BAR

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The H-46 helicopter has experienced early in-service failures in its tie bar. The tie bar is a multi-component systems that is a critical part of the linkage, which attaches the rotor blade to the rotating hub of the helicopter. This research developed methodology to predict the life of the tie bar under nominal operational flight loads. A probability model is indispensable because a revised design has yet to accumulate field data, and laboratory testing can never be sufficiently extensive for non-parametric reliability prediction. An algorithm was developed for three and four component systems that will generate the probability of system failure based on the probability of failure in its components. Finite element analysis was conducted on the tie bar to determine stress on each component for all possible damage configurations of the tie bar. A given set of flight loads was resolved into boundary conditions for the stress analysis. A methodology was developed to determine the probability of failure of each component using an idealized load history, based on the expected stress-life (S-N) relation of the component at the stress levels experienced by the component. The result is a prediction method that can fortify laboratory results to predict the probability of failure of a system given the system load history. This model will be verified using the early in-service failure statistics of the current design and can be used to assess revised designs. The model will provide a prediction of the failure distributions, (the bell-shaped distribution) as a function of flight hours, for one, two, three, and four elements of failures within the leaves of the tie bar.

THE APPLICABILITY OF NEURAL NETWORKS TO IONOSPHERIC MODELING IN SUPPORT OF RELOCATABLE OVER-THE-HORIZON RADAR

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Ionospheric models have been developed to interpret Relocatable Over-the-Horizon Radar data. This thesis examines the applicability of neural networks to ionospheric modeling in support of Relocatable Over-the-Horizon Radar. Two neural networks were used for this investigation. The first network was trained and tested on experimental ionospheric sounding data. Results showed neural networks are excellent at modeling ionospheric data for a given day. The second network was trained on ionospheric models and tested on experimental data. Results showed neural networks are able to learn many ionospheric models and the modeling network generally agreed with the experimental data.

AN INVESTIGATION OF THE TRANSONIC PRESSURE COEFFICIENT FOR AXI-SYMMETRIC BODIES

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This thesis investigates the pressure drag coefficient in the transonic regime over an axi-symmetric body, with a set of unique contour surfaces developed in a previous thesis. The contour surfaces were obtained by an exact solution of the small perturbation transonic equation, using the guidelines and tools developed at NPS. In this work, Computational Fluid Dynamics (CFD) was not only used to compute the afterbody contour surface, but also to investigate a conical afterbody and complete bodies, which are composed of an arbitrary forebody (ellipsoid) and variable afterbody (contour and conical). Euler as well as Navier-Stokes flow-solvers were applied to the geometries of interest, giving Mach-number contours for viscous and inviscid flow, pressure drag coefficient magnitude, and depicting shock wave locations. On the basis of these results, it can be verified that our contour surface afterbodies will decrease by 15% the peak of the pressure drag coefficient ($_d$) versus Mach number curves in the transonic regime. These results can be used to design low pressure drag surfaces for such shapes as missiles, projectiles and aircraft engine nacelles.

ANODE SHEATH CONTRIBUTIONS IN PLASMA THRUSTERS
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Contributions of the anode to Magnetoplasmadynamic (MPD) thruster performance are considered. High energy losses at this electrode, surface erosion, and sheath/ionization effects must be controlled in designs of practical interest. Current constriction or spotting at the anode, evolving into localized surface damage and considerable throat erosion, is shown to be related to the electron temperature's (T_e) rise above the gas temperature (T_0). An elementary one-dimensional description of a collisional sheath which highlights the role of T_e is presented. Computations to model the one-dimensional sheath are attempted using a set of five coupled first-order, nonlinear differential equations describing the electric field, as well as the species current and number densities. For a large temperature nonequilibrium (i.e.,$T_e >> T_0$), the one-dimensional approach fails to give reasonable answers and a multidimensional description is deemed necessary. Thus, anode spotting may be precipitated by the elevation of T_e among other factors. A review of transpiration cooling as a means of recouping some anode power is included. Active anode cooling via transpiration cooling would result in (1) quenching T_e, (2) adding "hot" propellant to exhaust, and (3) reducing the local electron Hall parameter. However, significant technical problems remain.

COLD FLOW SIMULATION OF THE ALTERNATE TURBOPUMP DEVELOPMENT TURBINE OF THE SPACE SHUTTLE MAIN ENGINE HIGH PRESSURE FUEL TURBOPUMP
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Completion of the installation at the Naval Postgraduate School of a cold-flow test facility for the turbine of the Space Shuttle Main Engine High Pressure Fuel turbopump is reported. The article to be tested is the first stage of the 'Alternate turbopump Development' model designed and manufactured by Pratt & Whitney. The purpose of the facility is to enable the development of non-intrusive flow measurements and comparison of those measurements with numerical simulation. Flow field characteristics of the turbine stator were predicted using a three-dimensional viscous flow code. A sensitivity study was conducted to determine the effect of inlet profile to flow field solution. Recommendations are made for future use of the test facility and validation of the numerical simulation scheme.

VIRTUAL PROTOTYPING AS AN AID FOR CONTROL SYSTEMS ANALYSIS
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Virtual Prototyping provides an opportunity for control engineers to observe and evaluate their designs in a "real world" setting without the costs or risks associated with flight test. *Designers Workbench* is a computer aided design tool that allows a user to create, view, modify and animate three-dimensional databases. These may include instruments, avionics displays and any *out-the-window* applications such as runways or terrain. The dynamic behavior os specific elements can be observed by *linking* data to the desired element. In this way a realtime animation of the simulation can be generated. The animation provides another analysis tool for the designer, by representing data in a more intuitive environment. Data files from two separate controller simulations was used. Cockpit instrumentation was modelled and used for each animation to monitor the aircraft states. In addition, each animation had an *out-the-window* perspective to view the aircraft model as it flew the prescribed trajectory.

LASER ANEMOMETRY AND VISCOUS COMPUTATION OF THE FLOW THROUGH AN ANNULAR TURBINE CASCADE

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An annular turbine cascade, designed for laser-Doppler velocimetry, was further modified to provide additional laser and pressure probe access. The purpose of the research was to devise laser anemometry measurement techniques in a confined annulus and improve the ability to compare numerical predictions with experimental results. Flowfield computations were completed using a viscous flow solver, with the numerical exit plane coincident with experimental measurement location. A data reduction program was written to transfer non-dimensional numerical output to the experimental coordinate system for comparison of total pressure ratio, Mach number and flow angle. Endwall two-dimensional laser measurements were obtained through a 1.0922 millimeter hole to a depth of approximately three millimeters.

A COMPUTATIONAL INVESTIGATION OF WAKE-INDUCED AIRFOIL FLUTTER IN INCOMPRESSIBLE FLOW AND ACTIVE FLUTTER CONTROL

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In this thesis several incompressible oscillatory flow and flutter problems are investigated. A previously developed unsteady panel code for single airfoil bending torsion flutter analysis is compared to Theodorsen's classical theory. The panel code agrees with published Theodorsen theory for natural frequency ratios ($\bar{\omega}_h/\bar{\omega}\alpha$) less than 1.2. In addition, a two airfoil unsteady panel code was modified for one degree of freedom flutter analysis. Code verification is completed by first comparing flat plate theory to the unsteady aerodynamic force and moment coefficients then using the equations of motion to determine regions of instability. The active control of flutter is investigated by positioning a small control airfoil in front of a neutrally stable reference airfoil. Results show that the flutter boundary may be changed through the placement, oscillation or scaling of a second airfoil upstream. A comparison to pitch damping curves published by Loewy confirms the USPOTF2F code is capable of predicting wake-induced airfoil flutter.

FLIGHT DYNAMICS OF AN UNMANNED AERIAL VEHICLE

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Moments of inertia were experimentally determined and longitudinal and lateral/directional static and dynamic stability and control derivatives were estimated for a fixed wing Unmanned Air Vehicle (UAV). Dynamic responses to various inputs were predicted based upon the estimated derivatives. A divergent spiral mode was revealed, but no particularly hazardous dynamics were predicted. The aircraft was then instrumented with an airspeed indicator, which when combined with the ability to determine elevator deflection through trim setting on the flight control transmitter, allowed for the determination of the aircraft's neutral point through flight test. The neutral point determined experimentally corresponded well to the theoretical neutral point. However, further flight testing with improved instrumentation is planned to raise the confidence level in the neutral point location. Further flight testing will also include dynamic studies in order to refine the estimated stability and control derivatives.

COMBUSTOR AND NOZZLE EFFECTS ON PARTICULATE BEHAVIOR IN SOLID ROCKET MOTORS

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An investigation was conducted using a subscale solid rocket motor to measure the effect of nozzle residence time on the behavior of $A1_20_3$ particles to assess the applicability of subscale motor data to full-scale motors and to measure the effects of nozzle entrance particle size distribution on the slag accumulated with submerged nozzles. Although particles as large as 140 _m were present at the nozzle entrance, most of the particulate mass was contained in much smaller particles. The observation is in good agreement with the small mass that accumulated above the submerged nozzle. It was found that both particle breakup and collision coalescence occurred across the exhaust nozzle, with a significant increase in the mass fraction of small (<2 _m) particles. Increasing the nozzle residence time enhanced particle breakup but did not affect the maximum plume particle size. Thus, full-scale motors are expected to have a higher percentage of mass in particles less than 2 _m than subscale motors but with similar diameters of the largest particles.

MASTER OF SCIENCE
IN
ASTRONAUTICAL ENGINEERING

ANALYSIS AND RELATIVE MOTION PLOTTING SOFTWARE FOR STS-51

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Master of Science in Astronautical Engineering-March 1994
Aeronautical and Astronautical Engineer-March 1994
Advisor: Rudolf Panholzer-Space Systems Academic Group

This thesis outlines the objectives, structure, and operation of the software designed to meet requirements set forth by Development Test Objective 700-6 for the space shuttle Discovery mission STS-51. The primary goals were the comparison of state vector information produced by GPS sources and Discovery's inertial navigation computer, and the real-time display of relative position and rendezvous information between Discovery and a retrievable shuttle pallet satellite. In-flight and post-flight examination of GPS and inertial state vectors provided the first step in the development of GPS as an on-orbit navigation system. Analysis of the Orbiter and target satellite state vectors produced real-time graphical displays of operationally significant data to the Discovery's flight crew during rendezvous and proximity operations.

THEATER BALLISTIC MISSILE DEFENSE SYSTEM ARCHITECTURE AND AN APPROACH TO SOLVING THE MULTIPLE REPORT PROBLEM

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M.S., University of Tennessee, 1991
Master of Science in Astronautical Engineering-September 1994
Advisor: Herschel Loomis-Department of Electrical and Computer Engineering

The purpose of this thesis is two-fold. First, this thesis defines the Theater Ballistic Missile (TBM) problem, the systems involved in Theater Ballistic Missile Defense (TBMD), and the connectivity among the systems, or the system architecture. Secondly, having defined the system architecture and having identified the problems associated with the system architecture, this thesis proposes a solution to managing TBM data from multiple channels and from multiple sources at the in-theater operator and in-theater commander level. This problem is defined as the multiple report problem. Included in this thesis is an in-depth discussion of the space based sensors used in TBM warning, the tactical and strategic processors used for downlinked data, the data distribution networks used in transferring the processed data and the current and proposed Tactical Event Report System (TERS) architecture. The Aerospace Corporation's *Joint Tactical Event System Architecture Study for U.S. Naval Space Command* is used in defining the multiple report problem and is the basis for the thesis' approach to solving the multiple report problem. The approach to solving the multiple report problem is intended as a "skeleton diagram" from which to proceed for a more specific solution. The conclusions and recommendations describe areas to be considered in furthering a more detailed solution to the multiple report problem.

FIRST PRINCIPLES USED IN ORBITAL PREDICTION AND AN ATMOSPHERE MODEL COMPARISON

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Master of Science in Astronautical Engineering-June 1994
Advisor: Richard C. Olsen-Department of Physics

This thesis develops an orbital prediction model based on fundamental principles of orbital dynamics and drag. A FORTRAN based orbital prediction scheme was designed to provide accurate ephemerides for a particular DoD satellite program. The satellite program under study has satellites at 650 and 800 kilometers with high inclinations. In order to obtain the highest accuracy possible, a comparison of atmospheric models had to be conducted in order to determine which model was more accurate. Mathematical formulation for three widely used earth atmospheric models are presented; the JACCHIA 60, JACCHIA 71, and MSIS 86 atmospheric models. The MSIS 86 atmospheric model was not evaluated due to computer problems. Comparison of the two JACCHIA models proved that the JACCHIA 71 model provided much more accurate ephemerides. It is believed that this is due not only to the incorporation of variations in density caused by solar flux, but also geomagnetic activity and a better modeling of the polar regions. Further work on this project would include incorporation of the MSIS 86 model for evaluation, incorporation of the full WGS-84 geopotential model, and using more accurate observed vectors in order to obtain a better comparison. Incorporating a subroutine which will vary the B-factor as a function of latitude will greatly increase accuracy. This is a major deviation from current operational practice, in that the B-factor is often used as an error catch-all and does not truly represent its dynamical purpose.

LIFETIME AND REENTRY PREDICTION FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

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Master of Science in Astronautical Engineering-June 1994
Advisor: I. Michael Ross-Department of Aeronautics and Astronautics

The Naval Postgraduate School (NPS) is developing a small satellite for digital communications in the amateur frequency band. The Petite Amateur Navy Satellite (PANSAT) will primarily act as an orbiting spread-spectrum communications laboratory, possesses neither an attitude control nor a propulsion system and is designed to "tumble" along its orbital path once it is released from the launch vehicle which is scheduled to be the Space Shuttle. An explanation of the many variables and assumptions affecting PANSAT is provided as insight for the lifetime and reentry predictions. Using a conservative approach, results from combining altitudes and inclinations from expected Space Shuttle missions, solar flux and magnetic indices from three different sources, and the use of an orbital propagator program, LIFETIME 4.1, which was developed by Aerospace Corporation, attest that the minimum 2 year lifetime requirement for PANSAT will be met by 9 Shuttle missions between July 1996 and December 1997. A reentry analysis concluded that PANSAT will experience sufficient aerodynamic forces to cause structural failure and breakup during atmospheric reentry.

A COMPUTER CODE (SKINTEMP) FOR PREDICTING TRANSIENT MISSILE AND AIRCRAFT HEAT TRANSFER CHARACTERISTICS

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Master of Science in Astronautical Engineering-September 1994
Advisor: Conrad F. Newberry-Department of Aeronautics and Astronautics

A FORTRAN computer code (SKINTEMP) has been developed to calculate transient missile/aircraft aerodynamic heating parameters utilizing basic flight parameters such as altitude, Mach number, and angle of attack. The insulated skin temperature of a vehicle surface on either the fuselage (axisymmetric body) or wing (two-dimensional body) is computed from a basic heat balance relationship throughout the entire spectrum (subsonic, transonic, supersonic, hypersonic) of flight. This calculation method employs a simple finite difference procedure which considers radiation, forced convection, and non-reactive chemistry. Surface pressure estimates are based on a modified Newtonian flow model. Eckert's reference temperature method is used as the forced convection heat transfer model. SKINTEMP predictions are compared with a limited number of test cases. SKINTEMP was developed as a tool to enhance the conceptual design process of high speed missiles and aircraft. Recommendations are made for possible future development of SKINTEMP to further support the design process.

A SIMULATION OF PLASMA MOTION IN THE POLAR IONOSPHERE

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B.S., United States Naval Academy, 1985
Master of Science in Astronautical Engineering-September 1994
Advisor: David D. Cleary-Department of Physics

A model of plasma motion in the polar ionosphere is presented. Plasma motion due to polar convection and corotation above 50° N is modeled. The universal time (UT)-dependent corotation electric field (in the geomagnetic frame) is added to a polar convection electric field that is UT-dependent in the geographic frame and the total is displayed in both reference frames. To simulate actual magnetic conditions, varying polar convection patterns may be used by the model we have developed. Trajectories of single plasma parcels and regions of plasma are calculated. The calculated trajectories are displayed in the geographic and magnetic inertial reference frames. The model developed is applied to the study of a region of electron depletion near the pole, a polar hole. Changes in the size and location of the polar hole are explained in terms of a changing convection pattern. The results of this thesis are being used by the Johns Hopkins University Applied Physics Laboratory to further study ionospheric plasma motion.

A COMPARISON OF DIFFERENT CONTROL METHODS FOR VIBRATION SUPPRESSION OF FLEXIBLE STRUCTURES USING PIEZOELECTRIC ACTUATORS

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Master of Science in Astronautical Engineering-June 1994
Advisor: Brij Agrawal-Department of Aeronautics and Astronautics

This paper compares the use of Phase Lead Control and Integral control methods to the Positive Position Feedback (PPF) method of suppressing the primary and secondary modes of vibration of a flexible structure. The basic characteristics of piezoelectric sensors and actuators are reviewed. Integral, Phase Lead, and PPF control methods of interest are also reviewed. The Integral and Phase Lead control methods prove to be comparable to that of PPF while offering a simpler implementation.

DESIGN AND ANALYSIS OF THE LAUNCH VEHICLE ADAPTER FITTING FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

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Master of Science in Astronautical Engineering-September 1994
Advisor: Sandra L. Scrivener-Department of Aeronautics & Astronautics

The Petite Amateur Navy Satellite (PANSAT) is a small communications satellite being developed at the Naval Postgraduate School. This thesis provides a structural design and analysis for adapter fitting which mates PANSAT to the space shuttle Get Away Special (GAS) cannister launching system. Launch vehicle loading and interface requirements were combined with PANSAT design priorities to determine design specifications. Structural Dynamics Research Corporation's I-DEAS Masters Series software was utilized to model two adapter designs. The finite element solver in I-DEAS was used to analyze the two designs for strength and natural frequency. Design and analysis of fasteners, used to attach the adapter fitting to PANSAT, were also conducted. The results showed that a titanium alloy adapter, which does not shadow the solar arrays, and stainless steel fasteners exceeded all design specifications.

AN ANALYSIS OF A SINGLE-BURN ALGORITHM FOR LOW-EARTH ORBIT MAINTENANCE

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B.S., United States Naval Academy, 1986
Master of Science in Astronautical Engineering-June 1994
Advisor: I.M. Ross-Department of Aeronautics and Astronautics

With the requirement for a spacecraft to maintain an orbital altitude band, a simple energy balance algorithm has been developed using a combination radial distance and spacecraft specific energy for fixed-vector thruster control. While each trajectory produces a unique band, initial attempts at producing a pre-specified band have been unsuccessful. It is theorized that a certain radial bandwidth would correspond to a specific set of control parameters, and that by creating maps of the relationship between the two for various spacecraft configurations a method of maintaining the pre-specified band could be found. This thesis studies variations in spacecraft configurations and finds dependence of orbital bandwidth on thrust-to-drag ratio and ballistic coefficient. Also, within certain ranges of the control parameters, multiple trajectories produce equivalent radial bands. Analysis shows that all single-burn trajectories are characterized by similar efficiencies, and are less efficient than a Forced Keplerian Trajectory (FKT).

SOOT PARTICLE DENSITY DETERMINATION FROM A LASAR EXTINCTION MULTIPASS TECHNIQUE

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Master of Science in Astronautical Engineering-September 1994
Advisors: Oscar Biblarz and David W. Netzer-Department of Aeronautics & Astronautics

Methods of measuring soot particle densities have been of interest for several decades. Plume signature determination of both rocket and air-breathing engines is of concern when applied to pollution and theater missile bassistic defense strategies. Application of non-intrusive traditional techniques employing Bouguer's law relied on Sauter mean diameter, statistical deviation and the probability density function in order to compensate for the abiguities present in the extension of classical Mie theory. Our investigation developed an apparatus which will determine soot particle densities by measuring extinction from absorption of light energy transmitted through an exhaust plume. The method used was a two-pass technique using an optical phase conjugator (OPC) which returned the non-absorbed portion of light energy. When the apparatus was used with a retroreflector, it produced accurate results but did not compensate for thermal blooming or beam steering. Characteristics of a photorefractive crystal used in the OPC process allowed for the return of an incident beam corrected for aberrations. Although the OPC returned the phase conjugate of the incident beam its size precluded the return of all of the transmitted data because data was lost on the blossomed beam.

PRELIMINARY PANSAT GROUND STATION SOFTWARE DESIGN AND USE OF AN EXPERT SYSTEM TO ANALYZE TELEMETRY

Gregory Wade Lawrence-Lieutenant, United States Navy
B.S., United States Naval Academy, 1986
Master of Science in Astronautical Engineering-March 1994
Aeronautical and Astronautical Engineer-March 1994
Advisor: I. Michael Ross-Department of Aeronautics and Astronautics

The Petite Amateur Navy Satellite (PANSAT) is a digital communications satellite to be used by civilian amateur radio operators. The master ground station at the Naval Postgraduate School performs satellite commands, displays telemetry, trouble-shoots problems, passes messages, and controls an open loop tracking antenna. This paper concentrates on the telemetry subsystem, and interpretation with an Expert System. When commanding the satellite, the ground station software will verify the instruction with a ground-based simulator before it is sent to the satellite. Telemetry is displayed in an easily interpretable format, so that any user can understand the current health of the satellite and be cued to any problems and possible solutions. Only the master ground station has the ability to receive all telemetry and send commands to the spacecraft; civilian ham users do not have access to this information. The telemetry data is decommutated and analyzed before it is displayed to the user, so that the raw data will not have to be interpreted by ground users. The analysis will use C Language Integrated Production System (CLIPS) imbedded in the code, and derive its inputs from telemetry decommutation. The program is an expert system using a forward chaining set of rules based on the expected operation and parameters of the satellite. By building the rules early in construction and design satellite, the telemetry can be well understood and interpreted after the satellite is launched and the designer may no longer be available to provide input to the problem.

NUMERICAL OPTIMIZATION OF SYNERGETIC MANEUVERS

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Master of Science in Astronautical Engineering-June 1994
Aeronautical and Astronautical Engineer-June 1994
Advisor: I. Michael Ross-Department of Aeronautics and Astronautics

The use of atmospheric forces to produce an orbital plane change requires less energy than a pure exoatmospheric propulsion maneuver. The combination of aerodynamic and propulsive forces to cause a change in orbital inclination is termed a synergetic maneuver. Several methods have been proposed to control the critical heating rate while performing the procedure. This thesis examines these control methods by numerically optimizing the trajectory for several fuel weights and heat rate constraints. The Program Optimize Simulated Trajectories (POST) is used to simulate the maneuvers and control schemes, and to perform the optimization. For no active heat constraints, it is shown that a gliding atmospheric entry followed by a maximum throttle "bang" produces significantly more inclination change than other proposed maneuvers. If the heat constraints are active, the recently proposed aerobang maneuver produces a substantial inclination change while providing significant heating rate control and shows definite advantages over the long-studied aerocruise maneuver.

THERMAL ANALYSIS OF PANSAT BATTERIES AND ELECTRICAL POWER SUBSYSTEM

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B.S., United States Naval Academy, 1982
Master of Science in Astronautical Engineering-September 1994
Advisor: I. Michael Ross-Department of Aeronautics & Astronautics

The thermal design of a spacecraft ensures proper heat transfer so al components and subsystems remain within prescribed temperature limits during all aspects of the spacecraft's mission. This thesis develops a point-to-point heat flow model of the Electrical Power Subsystem (EPS) and its associated housing for the Petite Amateur Navy Satellite (PANSAT). The analysis was performed to identify physical locations in the EPS where temperatures may exceed the limits established to protect sensitive electronic components, and to define the expected environment of the batteries. The Integrated Thermal Analysis System (ITAS) and a Steady State Thermal Analyzer and Model Builder were used to perform steady state and transient analyses on the EPS: analysis of the batteries was performed using ITAS only. The simulated transient temperatures within the EPS housing remained within limits, but the batteries exceeded specifications. It is suggested that a passive thermal control technique be adapted for the batteries and its design be experimentally validated before flight.

AN ANALYSIS OF ORBITAL PROPAGATORS FOR
LOW EARTH ORBIT RENDEZVOUS

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Master of Science in Astronautical Engineering-September 1994
Advisor: Clyde Scandrett-Department of Mathematics

This thesis examines the performance of three different orbital propagators to determine which provides the best performance for use in Low Earth Orbit Rendezvous. The performance evaluation is based upon the propagator's accuracy and the amount of time required to produce a solution. A Cowell high-fidelity propagator is used as a base line for comparison with an Encke and Clohessy-Wiltshire propagator. To further enhance the examination a Jacchia-70 atomospheric model and a GEM-9 Geopotential model are used to provide perturbing acceleraton inputs to the propagators. All comparisons are performed in a Local Vertical, Local Horizontal Reference Frame with the target spacecraft at the coordinate center. Tainting of the input data set by a prior processor make the findings suspect. Findings support the prediction that while the Cowell propagator is the most accurate it also takes the most time to achieve results. Also, the Clohessy-Wiltshire, while taking the least time is the most inaccurate. The Encke propagator delivers the most balanced result.

ANALYSIS OF THE FIRST SUCCESSFUL FLIGHT OF GPS ABOARD THE SPACE SHUTTLE

Stephen Paul Rehwald, Jr.-Lieutenant, United States Navy
B.S., United States Naval Academy, 1986
Master of Science in Astronautical Engineering-March 1994
Advisor: Randy L. Wight-Space Systems Academic Group
and
Carolyn Louise Tyler-Lieutenant, United States Navy
B.S. Mary Washington College, 1986
Master of Science in Astronautical Engineering-March 1994
Advisor: Randy L. Wight-Space Systems Academic Group

A Trimble Advanced Navigation Sensor (TANS) Quadrex Global Positioning System (GPS receiver processing unit and three antenna/preamplifier assemblies were flown aboard Space Shuttle Discovery, STS-51, as part of DTO 700-6, GPS On-orbit Demonstration (GOOD). The experiment was designed to quantify advantages and identify potential problem areas for Space Shuttle GPS operations using a low cost, commercial, space configured, GPS receiver. GPS data, including position, velocity, time, health, and status information were recorded during the mission. Following the mission, a reference trajectory was generated by NASA Johnson Space Center through post-processing of the Orbiter's on board navigation state. The recorded GPS data has been analyzed and compared to the reference trajectory to evaluate the navigational performance of the receiver. Additionally, post-flight filtering of the GPS data has been performed in order to determine whether a significant increase in performance may be obtained through filtering.

ANODE SHEATH CONTRIBUTIONS IN PLASMA THRUSTERS

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Aeronautical and Astronautical Engineer-March 1994
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Contributions of the anode to Magnetoplasmadynamic (MPD) thruster performance are considered. High energy losses at this electrode, surface erosion, and sheath/ionization effects must be controlled in designs of practical interest. Current constriction or spotting at the anode, evolving into localized surface damage and considerable throat erosion, is shown to be related to the electron temperature's (T_e) rise above the gas temperature (T_o). An elementary one-dimensional description of a collisional sheath which highlights the role of T_e is presented. Computations to model the one-dimensional sheath are attempted using a set of five coupled first-order, nonlinear differential equations describing the electric field, as well as the species current and number densities. For a large temperature nonequilibrium (i.e.,$T_e >> T_o$), the one-dimensional approach fails to give reasonable answers and a multidimensional description is deemed necessary. Thus, anode spotting may be precipitated by the elevation of T_e among other factors. A review of transpiration cooling as a means of recouping some anode power is included. Active anode cooling via transpiration cooling would result in (1) quenching T_e, (2) adding "hot" propellant to exhaust, and (3) reducing the local electron Hall parameter. However, significant technical problems remain.

INVESTIGATION OF THE EFFECTS OF SOLID ROCKET PROPELLANT COMPOSITION ON PLUME SIGNATURE

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Master of Science in Astronautical Engineering-June 1994
Advisor: David W. Netzer-Department of Aeronautics and Astronautics

Three propellants with aluminum/silicon weight percentages of 18/0%, 13.5/4%, and 12/6% were fired in a subscale motor to determine if the plume infrared signature could be reduced without a significant loss in a specific impulse. Spectral measurements from 2.5 to 5.5 μm and thermal measurements form 3.5 to 5.0 μm were made. Plume particle size measurements showed that only particles with small diameters (less than 1.93μm) were present with any significant volume. Replacing a portion of the aluminum in a highly metallized solid propellant with silicon was found to eliminate the Al_2O_3 in favor of SiO_2 and $Al_6Si_2O_{13}$, without any change in particulate mass concentration or any large change in particle size distribution. These particulates were found to have significantly lower absorptivity than Al_2O_3. An additional investigation was conducted to determine the particle size distribution at the nozzle entrance. Malvern ensemble scattering, phase-Doppler single particle scattering and laser transmittance measurements made through windows in the combustion chamber at the nozzle entrance indicated that large particles were present (to 250μm). However, most of the mass of the particles was contained in particles with diameters smaller than 5μm. Approximate calculations made with the measure data showed that if 100 μm particles are present with the smoke (particles with diameters less than 2μm) they could account for only approximately 10% of the particle volume.

COMPUTER GRAPHICS TOOLS FOR VISUALIZING GRAVITY GRADIENT TORQUES ON A RIGID SPACECRAFT

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Advisor: I. Michael Ross-Department of Aeronautics & Astronautics

This thesis provides students with a set of graphics tools allowing them to better visualize the effects of gravity-gradient torques on a rigid spacecraft in a low earth orbit. It allows the user to select from a variety of rigid bodies of different configurations, place them in any orientation at any altitude, apply the appropriate gravity-gradient moments to the body and immediately see the effect on the rigid body. This is accomplished through interactive computer graphics routines, written to run on Silicon Graphics computers. The thesis includes a presentation of the theory involved in the programming of the physical properties and then discusses the basics of computer graphics including a more detailed look at the specific implementation for this thesis. A detailed user's guide is included to train students to use the tools as expeditiously as possible. It concludes with recommendations for further study in this area.

DESIGN OF A COLD FLOW TEST FACILITY FOR THE HIGH PRESSURE FUEL TURBOPUMP OF THE SPACE SHUTTLE MAIN ENGINE

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Master of Science in Astronautical Engineering-December 1993
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The design and installation at the Naval Postgraduate School of a cold flow test facility for turbine of the high pressure fuel turbopump of the Space Shuttle Main Engine, is reported. The specific article to be tested is the "Alternate Development Model" designed and manufactured by Pratt & Whitney. The design of the individual components is documented. The installation of the facilities subsystems is described in detail. A preliminary estimation of turbine performance is made.

ANALYSIS OF THE FIRST SUCCESSFUL FLIGHT OF GPS ABOARD THE SPACE SHUTTLE

Carolyn Louise Tyler-Lieutenant, United States Navy
B.S. Mary Washington College, 1986
Master of Science in Astronautical Engineering
Advisor: Randy L. Wight-Space Systems Academic Group
and
Stephen Paul Rehwald, Jr.-Lieutenant, United States Navy
B.S., United States Naval Academy, 1986
Master of Science in Astronautical Engineering-March 1994
Advisor: Randy L. Wight-Space Systems Academic Group

A Trimble Advanced Navigation Sensor (TANS) Quadrex Global Positioning System (GPS receiver processing unit and three antenna/preamplifier assemblies were flown aboard Space Shuttle Discovery, STS-51, as part of DTO 700-6, GPS On-orbit Demonstration (GOOD). The experiment was designed to quantify advantages and identify potential problem areas for Space Shuttle GPS operations using a low cost, commercial, space configured, GPS receiver. GPS data, including position, velocity, time, health, and status information were recorded during the mission. Following the mission, a reference trajectory was generated by NASA Johnson Space Center through post-processing of the Orbiter's on board navigation state. The recorded GPS data has been analyzed and compared to the reference trajectory to evaluate the navigational performance of the receiver. Additionally, post-flight filtering of the GPS data has been performed in order to determine whether a significant increase in performance may be obtained through filtering.

THERMAL ANALYSIS OF PANSAT ELECTRIC POWER SUBSYSTEM

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Master of Science in Astronautical Engineering-June 1994
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Spacecraft thermal-control subsystems are necessary to maintain all elements of a spacecraft system within their temperature limits for all mission phases. In most instances the heat inputs are highly variable with time, requiring thorough transient-analysis of thermal flow within the spacecraft. Additionally, steady-state thermal profiles are necessary for precise overall thermal-analysis. The objective of this thesis is to develop a steady-state thermal model of the Electric Power Subsystem (EPS) and its associated housing for the Petite Amateur Navy Satellite (PANSAT). This task is undertaken to identify any physical locations within the EPS where temperatures exceed the limits established to protect sensitive electronic components. Software generated steady-state analysis using only contact-conductances for the EPS through the housing attachment is performed. It is shown that given the geometry of the physical model, the conductive relations developed, and the given boundary conditions, the steady-state temperature of the EPS and its associated housing will remain within limits.

MASTER OF SCIENCE
IN
APPLIED PHYSICS

SPACE TETHER-RADAR DATA PROCESSING

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Master of Science in Electrical Engineering-September 1994
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NASA conducted the Delta-PMG tethered satellite mission. It was conducted to verify the hollow cathode plasma source's ability to couple electric currents from each end of a long wire tether traversing the ambient low earth orbit ionosphere plasma. Observations were obtained through a suite of sensors which included large ground based VHF radars. The goal of this thesis was to process the radar data received at the radar based in Hawaii to study disturbances in the Earth's ionosphere caused by the tether. After extensive analysis, unique radar returns were identified that were associated with the passage of the tether system through magnetic field lines threading the radar's field of view. These returns were interpreted as a plasma cloud propagating along a magnetic field line and reflecting back along another. This phenomenon produced dual returns with inverted Doppler frequency content.

MODELLING TOOLS FOR ACTIVE CLASSIFICATION IN SHALLOW WATER ENVIRONMENTS

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Master of Science in Applied Physics-September 1994
Master of Science in Physical Oceanography-September 1994
Advisors: James H. Miller-Department of Electrical & Computer Engineering and
Ching-Sang Chiu-Department of Oceanography

Several tools have been developed, primarily using MATLAB, for modeling the active return of a target in an arbitrary, three-dimensional ocean environment and for quantifying the environmental distortion and interference. An acoustic model based on ray theory is used to compute the target echo and reverberation. These tools have been applied to Barents Sea and Gulf of Sidra ocean environments for a billboard transmit/receive array of 25 equally spaced elements. The frequency dependence of a sonar target's echo depends on its size, shape, wall thickness, and acoustic impedance. Active classification involves using this "signature," or transfer function, to classify the target and reduce or eliminate false ocean environments, particularly in shallow water. Multiple paths, reverberation, and ambient noise modify the received signal and make it difficult to extract the target's response. It is hoped that these tools will provide insight into the modelling and signal processing requirements for active classification as well as realistic signals for testing various schemes.

INFRARED POLARIZATION IMAGING CHARACTERISTICS

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Master of Science in Applied Physics-September 1994
Advisor: Alfred W. Cooper-Department of Physics

Experiments were conducted to investigate the use of polarization to improve target contrast discrimination of infrared images in the coastal environment. Polarized images of a U.S. Coast Guard 44-Foot Motor Lifeboat (MLB) were collected in the vicinity of Monterey Harbor and compared with previous data from larger vessels from the 1993 NATO MAPTIP experiments. Analysis of the available data showed that horizontal polarization provides increased contrast improvement over vertical polarization. Polarization from the MLB was small, while emitted radiation from the sea background was shown to be vertically polarized. The results are consistent with earlier experimentation, but were subject to interference from differences in target size and increased motion effects. Methods of improving data acquisition techniques for the AGA 780 dual-band (3-5 and 8-12 micron) radiometric imaging system are discussed. These networks include designing a split-filed polarimeter to allow simultaneous polarized imaging, and the reduction of the Narcissus effect.

MASTER OF SCIENCE
IN
APPLIED SCIENCE

AN EXPLORATORY STUDY OF NEURO-LINGUISTIC PROGRAMMING AND COMMUNICATION ANXIETY

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Master of Science in Applied Science-December 1993
Advisor: Gail F. Thomas-Department of Systems Management

This thesis is an exploratory study of Neuro-Linguistic Programming (NLP), and its capabilities to provide a technique or a composite technique that will reduce the anxiety associated with making an oral brief or presentation before a group, sometimes referred to as Communication Apprehension. The composite technique comes from NLP and Time Line Therapy, which is an extension to NLP. Student volunteers (17) from a Communications course given by the Administrative Sciences Department were taught this technique. For each volunteer, an informational oral presentation was made and videotaped before the training and another informational oral presentation made and videotaped following the training. The before and after training presentations for each individual volunteer were evaluated against criteria for communications anxiety and analyzed to determine if there was a noticeable reduction of anxiety after the training. Anxiety was reduced in all of the volunteers in this study.

A LIMITED ANALYSIS OF SOME NON-ACOUSTIC ANTISUBMARINE WARFARE SYSTEMS

Daniel Gerald Daly-Major, Canadian Air Force
B.Sc., Royal Roads Military College, Victoria, 1981
Master of Science in Applied Science-March 1994
Advisor: M.D. Kite-Department of Physics

The problem of Anti-Submarine Warfare early in the next century is examined. Nonacoustic detection methods including magnetic anomaly detection, laser radar, and hydrodynamic detection are examined. A simple analysis of their relative effectiveness is made.

THE EFFECTS OF LCAC LOAD POLICY ON THE DURATION OF AMPHIBIOUS ASSAULT

Sean Michael Peters-Lieutenant, United States Navy
B.S., Texas A&M University, 1987
Master of Science in Applied Science-March 1994
Advisor: A. Washburn-Department of Operations Research

A deterministic analytical model of LCAC operations is developed, based on the assumption that the mean time required to load the LCAC is an exponential function of the load weight. Simulation models of single queue and multiple queue LCAC operations are developed and the results compared to the deterministic model. Good agreement is obtained between the models. The results show that for most scenarios, the minimum time to complete the offload occurs for load sizes less than 60 tons.

APPROXIMATION OF THE FAST BOTTOM REFLECTION COEFFICIENT IN THE QUADRUPLET EXPANSION OF THE METHOD OF IMAGES IN A WEDGE SHAPED OCEAN

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B.S.C.E., Purdue University, 1987
Master of Science in Applied Science-March 1994
Advisor: A.B. Coppens-Department of Physics

Image theory is an ideal method for calculating the transmission loss in a shallow water (wedge shaped ocean) environment. It can be used in cross-slop, at all frequencies and in transitional cut off regions that are out of bounds to normal mode theories. This thesis had three objectives: 1) convert the existing image theory models called URTEXT and WEDGE into a high level scripting language called MATLAB ™ by Math Works, 2) linearize the existing quadruplet expansion program to increase speed, and 3) to incorporate the Arctan approximation of the Rayleigh reflection coefficient into the quadruplet expansion for the fast bottom case. Objective 1 was completed with accurate results. Objective 2 was completed with a factor of 8 increase in speed. Objective 3 incorporated the Arctan approximation of the reflection coefficient for a fast bottom into the quadruplet expansion, but due to the inaccuracy of the reflection coefficient after the second quadruplet, the results were not favorable. It was also discovered that even with the Rayleigh reflection coefficient, the first order approximations made in developing the quadruplet expansion equation (Equation 6-27) are not accurate enough for the fast bottom case.

MASTER OF SCIENCE
IN
COMPUTER SCIENCE

DEVELOPMENT OF COMPUTER-ASSISTED INSTRUCTION SYSTEMS TO FACILITATE READING SKILLS OF LEARNING-DISABLED CHILDREN

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The purpose of this thesis is to develop a high-level model to create self-adapting software which teaches learning-disabled (LD) children to read. The approach identifies and discusses the fundamental concepts of learning, motivation, learning disabilities, the Theory of Multiple Intelligence, computer games, and intelligent computer-aided learning (ICAL). These concepts are then integrated into the design of a model that manipulates these concepts to teach reading skills. The result of this effort is CAPER (Computer-Assisted Personal Education Resource). It is a model of a system that will: a) identify the individual's dominant learning styles, b) tailor the instruction and presentation to those styles, and c) present the lessons in an interactive game-like style that will retain the child's interest and enhance the learning process.

A CONCEPTUAL APPROACH TO OBJECT-ORIENTED DATA MODELING

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Master of Science in Computer Science-September 1994
Advisor: C. Thomas Wu-Department of Computer Science

Object-oriented data modeling is starting to replace the relational model for many recently emerging database applications. The complex nature of these databases precludes mapping of their data directly into a tabular relational structure. Current object-oriented data modeling lacks the standardization and mathematical soundness of the relational model. This thesis addresses this problem by proposing a conceptual data model called OPERA (Object Paradigm/Entity-Relationship Approach). OPERA incorporates the static features of the Entity-Relationship (ER) Model with the dynamic properties of object-orientation. In addition to OPERA, an object-oriented extension to the graphical query language GORDAS (Graph-Oriented Data Selection) is proposed. To demonstrate the effectiveness of the proposed model, we will model a United States combat systems support database, the WEIRDB (Electronic Warfare Integrated Reprogramming Database). We map the EWIRDB from its basic relational format to an object schema and then to an OPERA graph. Finally, this conceptual schema is mapped to a GORDAS schema graph and queries are performed on the database. OPERA is conceptually superior to the ER Model and its object-oriented variant, the Enhanced Entity-Relationship (EER) Model. We demonstrate this by representing methods as relationship types, which the ER and EER models are incapable of. OPERA also aids in query formulation visual query languages such as GORDAS by providing a query graph mapping template.

AUTOMATED NETWORK PROTOCOL REACHABILITY ANALYSIS WITH SUPERTRACE ALGORITHM AND TESTGEN: AUTOMATED GENERATION OF TEST SEQUENCE FOR A FORMAL PROTOCOL SPECIFICATION

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The automation of reachability analysis is an important step in verification of network protocols. The memory size needed for the full state analysis of complex protocols is usually very large and not available on most of the systems. A controlled partial search algorithm "Supertrace" is implemented in this thesis to analyze protocols that can not be analyzed efficiently by full state search method. Supertrace algorithm provided the analysis of large protocols by generating 80% to 95% more states and is much faster as total process time than full state analysis. The second problem addressed in this thesis is the improvement of conformance testing for protocol implementations. The "conformance testing" is used to check that the external behavior of a given implementation of a protocol is equivalent to its formal specification. A previously created procedure for conformance test sequence generation is automated in this thesis by the ADA programming language. The software tool implemented, uses a protocol specified formally with systems of communicating machines and creates test sequences as output. The tool was applied to a formal specification of the CSMA/CD and FDDI protocols and the results obtained, was consistent with the previous results. The automation of the tool expanded the applicability of the previous procedure to larger and more complex protocols.

DESIGN AND IMPLEMENTATION OF VISUAL OBJECT ORIENTED LOG

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and
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This thesis addresses the problem of how best to teach beginning programmers the necessary skills of object oriented programming. There is no established method of introducing object oriented concepts such as encapsulation, inheritance, and polymorphism, or providing a intuitive progression from simple programs to complex problem solving. The approach was to use tow commercially available programming languages which we consider exemplify good object oriented programming techniques, to teach beginners how to program. We selected LOGO, which has been used successfully in the past as a first programming language for children. Then we added the concepts of visual programming through the use of Prograph, a language which provides a visual, object oriented, dataflow environment. The main result of our research is the design and implementation of a prototype language called Visual Object Oriented LOGO (VOOL). VOOL is intended for use at all levels of education to teach problem solving, object oriented concepts, and fundamental programming skills. VOOL was implemented on a Macintosh int he pictorial, iconic language of Prograph and fully supports the goals of this thesis.

IMPROVING SOFTWARE CHARACTERISTICS OF A REAL-TIME SYSTEM USING REENGINEERING TECHNIQUES

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The major problem addressed by this research is how to improve an existing real-time software system's readability, maintainability, stability and portability using reengineering techniques. A fundamental portion of the Model-based Mobile robot Language (MML) was the real-time system chosen as the basis for this study. The approach taken was to create a new system design. The new design was based on system specifications obtained by conducting static and dynamic analysis on the existing system. The results are that a new core system was implemented using a design that focused on creating independent software sub-systems while encapsulating data. Hardware dependencies were localized and assembly code minimized. The new system is easier to understand and modify and is portable to other hardware platforms.

TYPE INFERENCE WITH OVERLOADING USING AN ATTRIBUTE GRAMMAR

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Advisor: Dennis M. Volpano-Department of Computer Science

Interactive programming environments for languages offer many advantages over traditional batch-oriented ones, such as immediate static analysis. One form of analysis is type checking, yet type checking in this setting for languages with common features like overloading has received little attention. We implement an interactive type checker for the polymorphic type system of ML with overloading. The implementation was produced automatically from an attribute grammar using the Synthesizer Generator, an attribute evaluator generator. Type inference then is accomplished via attribute evaluation so that if the evaluation is done incrementally, then type inference becomes incremental as well.

A MOBILE ROBOT SONAR SYSTEM WITH OBSTACLE AVOIDANCE

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The major problem addressed by this research is how to allow an autonomous vehicle to dynamically recognize changes in its environment, to map its environment, and alter its path to avoid obstacles while still reaching its goal point. The approach taken was to modify existing sonar functions in previous work, to better utilize sonars, and to perform many experiments to determine what data to expect from sonars while the vehicle is in motion. By applying the linear square fitting algorithm, the robot has the ability to map the objects within sensor range of an autonomous vehicle. The results are that, given an initial and goal point, the robot can proceed on a directed path, utilize its sonar sensor(s) used to detect obstacles, and when an obstacle is detected have the capability to dynamically compute a parallel path and smoothly alter its motion to the parallel path. The robot now has the capability to track the obstacle, and, once clear of the obstacle smoothly alter its motion to a path that will reach its goal point. The ability for the robot to combine smooth motion with obstacle avoidance has now been successfully programmed.

IMPLEMENTING AN OPEN OCEAN THEATER IN NPSNET

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Advisor: David R. Pratt-Department of Computer Science

The problems addressed by this research were to establish an efficient set of data structure and functions to implement a realistic open ocean environment, to create a conceptual representation of the ocean surface that realistically animates waves in real time and coordinates the dynamic motions of simulated marine vehicles sailing on the surface, and to establish an object-oriented paradigm for the incorporation of graphical user interface (GUI) components into the present NPSNET structure. The approach taken for this research was to develop a set of C++ classes that contained both the necessary data and methods to describe the ocean surface as a spatially organized hierarchy of dynamic geometric structures. The wave form associated with the surface was designed as a separate object to allow it to influence the periodic motions on surface marine vehicles as well as dictate wave height as any point and time. The results of this work are the Ocean and Wave classes, an extension to the NPSNET Vehicle class, and the modification of an OSF/Motif application framework library that supports the implementation of an IRIS Performer simulation. The extensibility of the system is enhanced through the expanded use of C++ objects, which was proven by the successful integration of NPSNET into the Motif application framework.

A HYPERTEXT-BASED INTELLIGENT LEARNING ENVIRONMENT FOR THE X WINDOW SYSTEM

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Intelligent tutoring systems have failed to achieve practical benefits commensurate with their potential for time First, the complexity and computational requirements of these systems often causes user interface design to be relegated to an ancillary role in the development cycle. savings, increased efficiency, and improved effectiveness. The problem consists of three inter-related factors. Second, creating an effective and usable interface is an inherently difficult task that often requires as much time and effort as the logical components. Finally, the lack of an intuitive and navigable interface interferes with the student's primary task of learning new material, precluding the success of these systems. Our approach is to provide an alternative framework for tutorial developers which assumes the burden of interface design. This framework consists of a hypertext-based instructional format that authors can easily convert their lessons into, facilitating rapid prototype development. By creating an Intelligent Learning Environment (ILE) designed to dynamically integrate hypertext-based tutors and reference materials, we can also provide users with a consistent, familiar, and highly navigable interface which will simplify the learning process. Using this approach we have successfully implemented an integrated environment for the X Window System. We have created a course of instruction for the Ada programming language, including the Ada 9X Language Reference Manual in hypertext format. The ILE may be dynamically extended through the modification of a text-based configuration file. This enables additional hypertext-based tutorials, reference manuals and help systems to be incorporated into the learning environment without requiring recompilation. This also allows developers to dynamically extend the functionality of individual tutor systems through the incorporation of student evaluation modules, software testing tools, or syntax directed editors.

THE DESIGN AND IMPLEMENTATION OF A FUNCTIONAL/DAPLEX INTERFACE FOR THE MULTIMODEL AND MULTILINGUAL DATABASE SYSTEM

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The Multi-Lingual and Multi-Model Database System (MDBS), at the Naval Postgraduate School, is the only database system in which five different database model interfaces operate on a single computer system. The purpose of the MDBS is to prove that multiple database models can coexist and share data within a single computer system. The MDBS provides a platform in which diverse database models can share data, via access to other models' base data, stored in the MDBS common format. The problem was that a Functional database model had not previously been implemented on the MDBS. The goal of this thesis was to provide a Functional/DAPLEX interface for the MDBS. The approach was to design and implement a set of programs to encapsulate the Functional/DAPLEX language as introduced by D.W. Shipman in 1981. It is imperative that the interface maintain the look, feel and characteristics of the Functional data model. The results are a set of programs, written in C, which implement a Functional/DAPLEX interface, thus a sixth interface, for the MDBS. The program parses DAPLEX data definition language and data manipulation language constructs, converts them to an MDBS common format, stores the data with other models' base data and can reconvert MDBS common data back to a Functional form.

IMPLEMENTATION OF MAGNETIC STRIP/SMART CARD TECHNOLOGIES AND THEIR APPLICATIONS AT NPS

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Various student management activities at the Naval Postgraduate School, Monterey, California are still using manual, labor-intensive, and inefficient methods. One such activity is the tracking of students attending the weekly Superintendent's Guest Lecture (SGL) series which requires a representative from each curriculum office to collect attendance cards for approximately 15 minutes and at least another three hours to sort out all the collected cards and generate the necessary reports. Is it possible to enhance student management activities, such as this, through implementation of Card Technologies? In order to answer this and other related questions, two card technologies were investigated. These were the magnetic tripe and smart card technologies. Included in this thesis is an in-depth look at both of these technologies with emphasis on general technical characteristics, their strengths and weaknesses, and their current applications. In addition, three simple applications have been developed for NPS as "proofs of concept" of the potential benefits that the school might gain from utilizing these technologies. We found that magnetic strip/smart card technologies can enhance various student management functions at NPS. The result of an experimental application developed to keep track of students attending the Superintendent's Guest Lecture showed that an absentee report, an important management document that is non-existent under the current system, can be generated rapidly with significant cost savings in terms of manpower requirements. Other applications utilizing smart card technology such as military ID, credit/debit card, and student check in/check out have been developed and tested successfully in the computer laboratory.

IMPROVEMENT OF JANUS USING 1-METER RESOLUTION DATABASE WITH A TRANSPUTER NETWORK

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Line-of-sight (LOS) calculation for the Janus combat simulation model is critical to the processes being simulated and impacts the run speed (ratio of game time to real time), since it may be the single most computationally expensive algorithm in simulation. This thesis presents design and implementation of a transputer network with the purpose of providing an efficient LOS calculation in a distributed memory and computing environment. The approach taken was to use a processor farming method to speed up the LOS calculation. The programs were implemented on a network of 15 transputers using 3L Parallel C++ (version 2.1.1) programming language. A 1-meter resolution terrain database of Fort Hunter Liggett, California was used to get more reliable LOS results. Expected gain of our system was 3.873 ($\sqrt{15}$). After timing tests, we found that we could speed up the LOS calculation by a factor of 2.581 when comparing the 15 transputer configuration to a conventional processor which is equivalent to a single transputer. The difference between expected gain and actual gain was found to be the communication overhead in the network transputers. We stated that further significant improvements can be provided by using our approach with more memory and faster transputers.

EFFECTIVE MANAGEMENT OF CLASSIFIED DOCUMENTS USING THE LIBRARY DOCUMENT SYSTEM

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Previous automated classified document systems developed commercially or in-house to serve classified libraries with 50,000 documents or less, have been limited by excessive cost or insufficient functionality. The problem addressed by this research was to improve the automated systems available to classified libraries with 50,000 documents or less, by upgrading the Library Document System (LDS) to meet the tracking and document search needs of librarians. The approach taken was to first conduct a survey of 25 classified libraries to assess their document tracking procedures and requirements. Next, a thorough examination of the commercial and in-house automated classified document systems was performed to determine the state of solutions available. Finally, a strategy for modifying LDS was outlined to incorporate the tracking and document search features desired, using modern relational database constructs, structured programming techniques, and user-friendly interface design. As a result of this work, LDS was upgraded to fulfill the needs of classified librarians with 50,000 documents or less. In particular, the schemata of the system were extended, a sophisticated search facility was implemented, and a mouse-oriented user-friendly interface was provided.

DESIGN AND IMPLEMENTATION OF VISUAL OBJECT ORIENTED LOG

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Civil Engineering, Polytechnic Senegal, 1985
and
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This thesis addresses the problem of how best to teach beginning programmers the necessary skills of object oriented programming. There is no established method of introducing object oriented concepts such as encapsulation, inheritance, and polymorphism, or providing a intuitive progression from simple programs to complex problem solving. The approach was to use tow commercially available programming languages which we consider exemplify good object oriented programming techniques, to teach beginners how to program. We selected LOGO, which has been used successfully in the past as a first programming language for children. Then we added the concepts of visual programming through the use of Prograph, a language which provides a visual, object oriented, dataflow environment. The main result of our research is the design and implementation of a prototype language called Visual Object Oriented LOGO (VOOL). VOOL is intended for use at all levels of education to teach problem solving, object oriented concepts, and fundamental programming skills. VOOL was implemented on a Macintosh in the pictorial, iconic language of Prograph and fully supports the goals of this thesis.

TRANSLATION OF THE DATA FLOW QUERY LANGUAGE FOR THE MULTIMODEL, MULTIBACKEND DATABASE SYSTEM

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This thesis involved the design and translation of the Data Flow Query Language (DFQL) for the Multi-Lingual, Multi-Backend Database System (MDBS). The MDBS is a database system that can effectively support multiple data models and their corresponding data manipulation languages. The problem was the MDBS interfaces are text-based, and not very user-friendly. The approach taken to solve this interface problem was to design and translate the DFQL for implementation on the MDBS. DFQL was designed to improve and extend SQL, the data manipulation language associated with the relational data model. It uses a graphical interface based on the data flow paradigm. This translation would extend the MDBS by allowing a graphical interface to be implemented, whereas currently a user can only access the system with text-based interfaces. The result of this thesis is the development of the DFQL to ABDL translator. The subsequent implementation of this translator on the MDBS would be a user-oriented enhancement to the current system. In addition, further improvements to the MDBS enhancement to the current system. In addition, further improvements to the MDBS should be made, such as allowing the use of additional data types (currently constrained to string and integer) and the ability to create views. These changes would allow all the benefits from DFQL, such as orthogonality, language extensibility and incremental querying to be achieved and made available to the user.

MEBUILDER: AN OBJECT-ORIENTED LESSON AUTHORING SYSTEM FOR PROCEDURAL SKILLS

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Many military applications for intelligent-tutoring systems focus on the training of procedural skills. However, while there have been many successful research efforts into developing tutoring systems for specific applications, the question of developing general-purpose ones is still open. Specifically unsolved is how a lesson-authoring system, a program written to help a novice write computerized lessons, can be made both general purpose and easy to use. MEBuilder is a prototype lesson-authoring system which employs an object-oriented approach to solving this problem. MEBuilder combines automated object, task, and lesson modeling tools with a library management system to allow teachers to develop simulation-based procedural trainers on nearly any subject. Teachers create reusable objects which have a fixed and well-defined behavior. Then by using the power of means-ends analysis, MEBuilder helps the teacher build entire tasks with these objects in just one step. With these tasks, teachers use MEBuilder's workbook structure to create a lesson containing several exercises. At each step, MEBuilder's automatic error and consistency checking reduces time spent on testing and debugging. MEBuilder's library manager ensures object and task reusability. This thesis explains MEBuilder's design, data structures, and interfaces. It also presents experimental results which support MEBuilder's methods as being more efficient and authoring systems using traditional computer-aided instruction (CAI) techniques.

THE COMPARISON OF SQL, QBE, AND DFQL AS QUERY LANGUAGES FOR RELATIONAL DATABASES

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Structure Query Language (SQL) and Query By Example (QBE) are the most widely used query languages for Relational Database Management Systems (RDBMS's). However, both of them have problems concerning ease-of use issues, especially in expressing universal quantification, specifying complex nested queries, and flexibility and consistency in specifying queries with respect to data retrieval. To alleviate these problems, a new query language called "DataFlow Query Language" (DFQL) was proposed. This thesis investigates the relative strengths and weaknesses of these three languages. We divide queries into four categories: single-value, statistical result, and set-count value. In each category, a representative set of queries from each language is specified and compared. Some of the queries specified are logical extensions of the other (already defined) queries, which are used to analyze the query languages' flexibility and consistency in formulating logically related queries. We perform a simple experiment of asking NPS CS students to write a small set of queries in all three languages. Based on the analysis, we conclude that DFQL eliminates the problems of SQL and QBE mentioned above. The relative strengths of DFQL comes mainly from its strict adherence to relational algebra and dataflow-based visuality.

GRAPHICAL SIMULATION OF ARTICULATED RIDGED BODY KINEMATICS WITH COLLISION DETECTION

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The area of concern addressed by this thesis is the development of a 3-D visual simulation to aid in the testing of ground detection and foot placement algorithms for an articulated walking robot's foot pads on uneven terrain. Several collision detection algorithms and terrain mapping techniques were studied to determine which approach would lend itself readily to the rapid detection of initial ground contact and the required orientation needed to place each foot firmly on the ground. As a result of these studies, a real-time, realistic and aesthetically pleasing graphical simulation for the testing of control software for articulated walking machines has been developed which utilizes the Silicon Graphics 3-D visual simulation toolkit, Performer. Not only is rapid ground contact sensing and foot orientation possible, it is accomplished without using extraneous data structures making the algorithm generic enough to use on any terrain model.

THE MERITS OF THE CONTINUED INSTRUCTION OF ADA AS A FIRST PROGRAMMING LANGUAGE AT THE NAVAL POSTGRADUATE SCHOOL

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This thesis addresses the issue of the continued instruction of structured programming in general and the Ada in particular as the first programming language at the Naval Postgraduate School. The catch-22 of industry's dedication to the C++ and the Department of Defense's support of Ada makes the choice of the proper language at a military graduate education school difficult. The change to the present curriculum provides an opportunity to collect valuable data upon which to base this decision. The approach was to identify the relative strengths and weaknesses of Ada and C++ as they pertain to first quarter non-computer science undergraduates and meeting the needs of Department of Defense directives. Additionally, a set of programming projects to be solved by students in both languages was generated. Analysis of the Students' work will provide another set of data points to make an informed decision. Based on its readability, standardization and its Department of Defense support, we conclude that Ada9X offers significant advantages over C++ and should be selected as the first programming language. Ada9X offers both the object oriented paradigm and is in line with the Department of Defense commitment to Ada for non-COTS applications.

LAYERED PATH PLANNING FOR AN AUTONOMOUS MOBILE ROBOT

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In order to continue to improve the usefulness of robots, it is becoming increasingly important to have them act as autonomous agents. A significant step toward this object is autonomous motion planning. This research was conducted as part of a broader effort to empower Yamabico-11, a mobile robot under development at the Naval Postgraduate School, with ability to move autonomously. We believe that this problem is best attacked in layers.
This thesis is our proposal for the initial layer. Given a robot's current location and its goal location, we use the homotopy relation to reduce the infinite set of path choice into a more manageable and smaller set of path classes. Specifically, we solve the problem of how to enable a robot to autonomously identify and label these classes of paths. We begin by decomposing the robot's operation environment into a collection of convex pieces called cells. the cells are transformed into a graph by adjacency. We show that every simple path on the graph corresponds to a unique simple homotopy class in the robot's world. We then search the graph to give each class a symbolic representation which also provides intermediate path planning clues. Subsequent layers can use these clues to form a more detailed plan. We implement the cell decomposition, graph transformation, and path class labeling as C programs, and preprocess them on a Unix workstation. The resulting data structures are then compiled and linked into the robot's kernel. All implementation has been integrated into the model-based mobile robot language (mml) used by Yamabico-11.

COMPUTER GRAPHICS TOOLS FOR THE VISUALIZATION OF SPACECRAFT DYNAMICS

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Master of Science in Engineering Science-December 1993
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This thesis consists of teaching tools designed to allow spacecraft engineering students to visualize the various phenomena associated with spacecraft dynamics. It does so via the use of state of the art three dimensional computer graphics on Silicon Graphics computers. The thesis discusses the principles in dynamics that were implemented and the key design considerations. A central goal was to develop applications that were user friendly. A library of functions were developed called Dynamics Programming Library or DPL. DPL shields the users from the details of computer graphics, thus allowing them to concentrate on the dynamics of the problem. DPL was used to write three main applications: Euler, Frame, and Gyro. Euler demonstrates the representation of orientation using Euler angles and quaternion rotation. Gyro demonstrates the effects of torques applied to varying rigid body geometries and inertias. Frame allows students to view the motion of an object from different frames of reference. A group of 21 spacecraft engineering students participated in a lab exercise using these programs. Within 20 minutes, the students could run the simulations thus validating their user friendliness.

AN EMPIRICAL APPROACH TO LOGICAL CLUSTERING OF SOFTWARE FAILURE REGIONS

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Previous work (Ginn, 1991) showed that faults in a program tend to cluster when viewed by the variables that affect execution and propagation of the fault (structural clustering). However, that study was quite preliminary and local in its investigation. This thesis examines clustering from two other perspectives, taxonomical (type of faults) and functional (area of affected functionality). The hypothesis tested was that faults tend to cluster when viewed from these perspectives. The approach was to use chi-square statistics on data taken from (Shimeall, 1991) to test the hypotheses, 247 faults were analyzed and the resultant clustering was cross-examined across the perspectives. The results show that the studied failure regions have a strong tendency to form taxonomical clusters. They also exhibit a mild tendency to form functional clusters. Taxonomical clustering does not correlate with structural clustering, while functional clustering correlates well with it.

DESIGN AND SYNTHESIS OF A REAL-TIME CONTROLLER FOR AN UNMANNED AIR VEHICLE

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The Naval Postgraduate School is developing a vertical take-off and landing (VTOL) unmanned air vehicle (UAV) that can transition to horizontal flight, once airborne, in order to take advantage of the improvements in speed, range, and loiter time that horizontal, fixed-wing flight provides. This research investigates the design requirements of the central controlling device for that UAV, including the specific problems of defining the necessary hardware components and developing software for executive control. First, hardware requirements needed to be determined. By exploring the general operational requirements of the UAV and taking into account space and weight limitations, a hardware suite was selected which could provide adequate functionality to replace the human traits of a pilot. In order to provide "awareness" of the operational environment, motion sensors, navigation equipment, and communication equipment was required. Controllable servo motors were necessary to move control surfaces appropriately. Computer hardware, necessary to provide system intelligence, was selected in order to interoperate with the other hardware. Next, a Real-Time Executive (RTE) software program was designed to provide the functionality and coordination of all hardware components. Device drivers for each component were developed, and overall coordination was planned using a Yourdon style essential model. Periodic interrupts were used to control execution time. Last, the specifications and configuration of all hardware components were completely documented, and the operation of the RTE program is fully explained. From this understanding of the overall control system, future development can continue, resulting in a more effective and efficient UAV design.

CONSTRUCTING A REAL-TIME MOBILE ROBOT SOFTWARE SYSTEM

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The problem with the Model-based Mobile robot Language (MML) processor is that the code is unstructured, causing the system to be unstable, it is very difficult to read because of deficient source code documentation; and because of poorly defined function interfaces and low functional coupling, the system is hard to maintain. To fix the MML processor, we performed a manual static analysis of the existing source code to understand its structure. Next, based on the analysis, the software system was restructured and the functionality enhanced. Finally, explicit source code documentation was added in the form of comments. There are several results with the new system. First, global variables are reduced from 152 to zero. Secondly, function interfaces are clearly defined and function coupling is enhanced. Finally, the source code is extensively documented. Following from these results, the new system is more stable, easier to read and understand,and simpler to modify.

THE WORLD MODELER: THE NEXUS BETWEEN JANUS AND BATTLEFIELD DISTRIBUTED SIMULATION-DEVELOPMENTAL

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The United States Army has two disparate combat models; Janus and Battlefield Distributed Simulation-Developmental (BDS-D). Both facilitate training, tactical development and weapons analysis. The major problem addressed by this research is that entities existing in the Janus Combat Modeler cannot interact with entities in BDS-D. If interaction is made possible, it would produce a synergy between the combined models, each model bringing advantages to the other. The approach taken was first to identify the differences between the two environments of Janus and BDS-D. Next, a software architecture was developed to store and manipulate data about both simulations. A communications architecture was created to allow data flow between the two environments. Finally, algorithms were developed to allow for interaction between Janus and BDS-D entities. The result was to integrate Janus, a two dimensional, constructive combat model, into the three dimensional, entity-level virtual battlefield of BDS-D. Janus entities interact in the real time with other entities in the BDS-D virtual world. The finished product, the World Modeler, is a software system operating on a low-end Silicon Graphics workstation with TCP/IP and UDP/IP networking capabilities.

A PERIODIC SCHEDULING HEURISTIC FOR MAPPING ITERATIVE TASK GRAPHS ONTO DISTRIBUTED MEMORY MULTIPROCESSORS

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Master of Science in Computer Science-September 1994
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This thesis investigates the problem of statically assigning the tasks of applications represented by repetitive task graphs (such as sonar or radar signal processing) to the processors of a distributed memory multiprocessor system with the objective maximizing graph instance throughput. The repetitive nature of these task graphs allows for pipelining and the overlapping of successive graph instances, suggesting a departure from classical directed acyclic graph scheduling techniques. To investigate such a claim, a version of the Mapping Heuristic (MH) [ELR 90] is extended for use with iterative applications. Then a new heuristic, Periodic Scheduling (PS), is developed to capitalize on the repetitive nature of these task graphs by overlapping successive graph instances. The PS heuristic assigns tasks to processors in such a way so as to minimize the maximal utilization of the processors and the communications links between them. This maximal utilization figure dictates the interval between successive instances of the task graph. We conduct experiments in which the graph instance throughput of PS is compared to that of MH across a broad range of processor topologies, utilizing several communications/computation ratios. It is shown that, compared to MH, the PS heuristic improves the throughput performance between two and 50 percent. Particularly noteworthy improvement is noted on systems with high average inter-node communications costs.

LARGE GRAIN DATA FLOW GRAPH CONSTRUCTION AND RESTRUCTURING UTILIZING THE ECOS WORKSTATION

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The U.S. Navy's new multiprocessor, the AN/UYS-2 Enhanced Modular Signal Processor (EMSP) utilizes a First-Come-First-Serve (FCFS) algorithm to transfer data. This algorithm is simple to implement but provides no mechanism to control execution of a specific application on the AN/UYS-2 which prevents performance predictions. A Large Grain Data Flow (LGDF) representation of a specific application is utilized to predict performance, with the introduction of trigger queues (dependency arcs) into the graphs to control execution. I utilized the EMSP Common Operational Software (ECOS) Workstation to execute graph representations of specific applications used by the U.S. Navy in the Anti-Submarine Warfare (ASW) arena. A complete description of the ECOS workstation, and the process of transforming specific applications into graph representations to be executed on the ECOS Workstation is demonstrated. Specifically, the Correlator Graph which represents a real-time ASW process is examined. To control and improve performance, the technique of implementing trigger queues using the ECOS Workstation is demonstrated. A basic graph is executed and referenced as a benchmark, with two reconstructed graphs executed demonstrating how trigger queues effect graph execution. The node execution times statistics indicate trigger queues control execution and will provide a mechanism to predict node performance.

A COMPUTER SIMULATION OF VEHICLE AND ACTUATOR DYNAMICS FOR A HEXAPOD WALKING MACHINE

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Underwater walking machines offer a potential for replacement of human divers in certain aspects of underwater construction and inspection. One such vehicle, Aquarobot, is currently under test in Japan. However, this vehicle is currently too slow to be economically utilized, and limited hardware availability restricts progress in control software improvements. A software dynamic simulation model is desirable to relieve this restricted access. The problem addressed by this research is the modeling of system dynamics of underwater walking vehicles with sufficient simplification to achieve a real-time simulation. The approach taken includes an object-oriented, massless leg robot dynamic model and employs a high performance graphics rendering toolkit. The resulting simulations of a robotic joint actuator and of the robot itself, utilizing springs and dampers in the joints, runs in real-time. The robot simulation model executes on a four-processor machine with under fifteen percent utilization of the processor dedicated to system dynamics. This result indicates that the simulation is likely to retain real-time capability after replacing the springs and dampers with the more accurate joint actuator model also developed in this thesis.

HIGH SPEED TRANSPORT PROTOCOLS: AN ATTEMPT TO FIND THE BEST SOLUTION

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The development and advances in fiber optic technology are leading to major changes in modern telecommunication systems. In short, the transmission of data through optical fiber has become so fast that the computers which the fibers connect have become a bottleneck. The transport layer protocol, which is the software interface between the network and the computer, is one of the most important sources of this bottleneck. The purpose of this thesis is to investigate several "high-speed" transport protocols, evaluate them and attempt to determine which transport protocol or combination of transport protocols is optimal for high speed networks of the future. The approach is to first study the requirements of transport protocols for high speed networks. Then the properties of several specific transport protocols are studied with these requirements in mind. A detailed analysis of the strengths and shortcomings of TCP/IP, XTP, and SNR are presented. TCP/IP, which is in wide use today, was designed when transmission rates were much slower and error rates were much higher than today. XTP and SNR are two new experimental transport layer protocols which have been recently designed with high speed networks in mind. The primary contribution of this thesis is an evaluation of the requirements of future transport protocols. In short, TCP/IP in its present form is simply not adequate; it must change and adapt, or replaced by a new transport protocol like XTP, or SNR.

THE STABLE AND PRECISE MOTION CONTROL FOR AN AUTONOMOUS MOBILE ROBOT

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The major problem addressed by this research is how to develop a motion control algorithm for stable and precise control of the motion of an autonomous mobile robot. The approach taken was to clearly define the robot's motion descriptions and to design a high-level, machine independent robot control language called MML (Mode-based Mobile robot Language). The results are that the robot can implement line to line, line to circle, circle to circle path tracking or the combinations of these. Based on the motion control algorithm which was developed in this thesis, the robot is able to use external sensors to execute complicated missions such as obstacle avoidance (sonar is used in this thesis work).

DEVELOPING AN OBJECT-ORIENTED CURRICULUM

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Traditional introductory computer science curricula do not address the emerging paradigm of object-oriented programming. The purpose of this research is to determine when object-orientation should be introduced into the computer science curriculum and what is the proper instructional approach to present this material. This thesis looks at the concepts incorporated by the object-oriented paradigm, explores the developmental psychology applicable to understanding new environments and proposes an introductory object-oriented curriculum that incorporates the fundamentals of learning, computer science and object-oriented programming. The object-oriented curriculum proposed provides a top-down approach to the conceptual foundations of computer science with a bottom-up approach to object-oriented programming. This combination of approaches provides the necessary breadth of coverage in algorithms, data structures, programming analysis and object-oriented modeling with an initial in-depth look at the mechanics of programming.

AUTONOMOUS AGENT INTERACTIONS IN A REAL-TIME SIMULATION SYSTEM

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The major problem addressed by this research is the design and implementation of a command and control architecture to add company-level missions to an existing real-time combat-simulation system. The US Army is using the Modular Semi-Autonomous Forces (ModSAF) simulator to conduct research in simulation training. ModSAF only provides platoon and vehicle missions. Adding company level missions to ModSAF will allow a single operator to effectively control a greater number of forces and retain realistic behaviors. The approach taken was to utilize ModSAF's finite-state machine architecture, and NPSNET -- a three dimensional combat-simulation system, to develop, test, and implement a company-level combat simulation mission. Simplistic terrain reasoning algorithms and a command and control finite state machine architecture were added to the ModSAF system. The result is a prototype company-level mission "Occupy and Assembly Area," providing a successful proof-of-concept implementation of company level mission development using ModSAF's current finite state machine architecture. This research provides the groundwork for further development of company-level combat simulations in ModSAF.

IMPROVEMENT OF JANUS TARGET ACQUISITION USING A FUZZY LOGIC HUMAN FACTOR MODEL

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Two questions have been addressed by this study. First, what factors affect human target detection, recognition, and identification performance? Second, how should these factors be simulated to provide enhanced realism in the JANUS (A) battlefield simulation system, specifically in the target acquisition phase of the JANUS (A) system? The approach taken was to survey subject matter experts, U.S. Army personnel familiar with target search and acquisition operations in real and simulated combat operations. Survey results were combined with previous research to model human factors effects on performance. A fuzzy logic model was implemented as a Common LISP computer program to show the feasibility and desirability of such a model for this type of human factors simulation. The results of this study include a set of human attributes and subfactors that affect target acquisition and that can be expanded as needed to model complex simulations of human battlefield performance. A working prototype fuzzy logic based program has been developed. The program provides an output that can be used for modifying the current JANUS (A) battlefield simulator target acquisition threshold for greater realism.

IMPLEMENTATION OF A TACTICAL MISSION PLANNER FOR COMMAND AND CONTROL OF COMPUTER GENERATED FORCES IN MODSAF

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The purpose of this work is to develop a three-level architecture for mission planning and task assignment to computer generated forces. This architecture is based on the Rational Behavior Model, which was constructed by Byrnes, et. al. as a means of mission planning and control for autonomous robots. Extending this concept to address the problems of mission planning for computer generated forces allows the human greater flexibility and capability in controlling large numbers of computer generated forces in a large-scale virtual environment. The base system used in this proof-of-concept prototype is the Modular Semi-Automated Forces system (ModSAF), which was developed by Loral ADS for US Army Simulation, Training, and Instrumentation Command, and written in C, using OSF/Motif as the graphical user interface (GUI) system. A prototype mission planner was added as a library to this application, using the US Army's five paragraph operations order as the basis for a series of GUI editors. The editors provide information to the framework about which artificial intelligence modules operate on the on the data input from the order, generating ModSAF tasks that are subsequently executed by the company. Currently, the input is parsed directly into a series of company-level ModSAF mission tasks. The initial results from the prototype resulted in a significant simplification of task generation for the user. One operations order phase generated on the average 2.5 ModSAF phases, with no requirements for additional parameter changes. Further research is needed, however, to fully determine the resource implications of including AI modules in an already complex system. The use of the operations order as a means to generate a company-level mission simplifies mission generation, but a robust expert system is needed to effectively convert the operations order input data to a set of ModSAF tasks.

THE USE OF TELEMETRY IN TACTICAL NETWORK MANAGEMENT

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This thesis addresses the issue of reporting the real-time status of equipment in a tactical telephone system. The U.S. Army is developing a system called the Integrated System Control to manage all tactical communication networks. However, this system does not provide the network managers with a rapid and efficient tool for identifying and diagnosing network outages based on equipment failure. The current semi-manual method for reporting system residuals and failures allows for erroneous and delayed information that often leads to extensive troubleshooting procedures. The approach was to determine if the tactical transmission assemblages can generate telemetry messages that contain the real-time status of the system's components. These messages would be routed through the tactical network to centralized nodal control element and processed as status information to the network manager. We conclude that it is possible for military signal equipment to generate raw data pertaining to the "health and welfare" of a tactical network. A recommendation is given for processing this telemetry data into a computer using a Windows environment. This allows the network manager to monitor alarms from all transmission assemblages and perform queries to quickly determine the cause of system failures.

MANDATORY SECURITY POLICY ENFORCEMENT IN COMMERCIAL OFF THE SHELF DATABASE MANAGEMENT SYSTEM SOFTWARE: A COMPARATIVE ANALYSIS OF INFORMIX ON-LINE/SECURE AND TRUSTED ORACLE

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The objective of this thesis is to analyze the mandatory access control (MAC) features of two commercial multilevel trusted database management systems (DBMS): Trusted ORACLE 7 and Informix-OnLine/Secure 5.0. We are attempting to determine how the problem of multilevel sharing of information is addressed at each multilevel secure DBMS. Commercially available documentation is used to examine the mandatory access controls enforced on labeled subjects and labeled objects and to compare them to the Class B1 requirements for MAC and labeling set forth in the Trusted Computer System Evaluation Criteria (TCSEC). A decomposition of the TCSEC requirements for MAC and labeling is mapped to the DBMS documentation to determine if the Class B1 requirements are met by each DBMS. With the TCSEC mapping a reference, the interface features in support of MAC are analyzed and compared between the products. This analysis shows that each DBMS uses different schema objects and privilege sets to enforce its mandatory security policy. The MAC mechanism of each product is based on the Bell-LaPadula security model, extended to prohibit the writeup of data from lower level subjects to higher level objects. Each DBMS allows traditional trusted subjects to writedown data. When special privileges are granted to users, readups and writeups are permitted in both DBMSs.

GRAIN SIZE MANAGEMENT IN REPETITIVE TASK GRAPHS FOR MULTIPROCESSOR COMPUTER SCHEDULING

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Optimal scheduling of parallel programs onto multiprocessor computers is an exponentially hard problem. Because of this, most scheduling algorithms is use today rely on heuristics to determine the best balance of computation and communication costs. However, because of the NP-hard nature of the problem, these heuristics have become very complex. We are concerned with a specific instance of the problem, throughput scheduling, which aims to optimize the completion rate of repetitive programs, expressed as task graphs, for which the computational and communication needs of the tasks are known in advance. We propose a simpler approach for finding better schedules, which involves testing different grain size modified versions of the task graph to find the one that results in the highest throughput for the given scheduling algorithm. Our heuristic works by alternately fusing of fissioning selected tasks of the graph then evaluating the modified task graph by measuring the expected throughput of its resultant schedule. Because of the generality of this approach, it can be applied to any scheduling algorithm that does not already include grain size modification. We test the new heuristic using simulation of the Navy's new standard digital signal processor, the AN/UYS-2, and using various task graphs and scheduling algorithms. We show that this practical approach to scheduling can increase throughput of the Largest Process Time first algorithm by at least 16 percent for our model computer configured with four, eight, or sixteen processors.

EVALUATION OF HARDWARE AND SOFTWARE FOR A SMALL AUTONOMOUS UNDERWATER VEHICLE NAVIGATION SYSTEM (SANS)

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The purpose of this thesis is to evaluate the hardware and software for a Small Autonomous Underwater Vehicle (AUV) Navigation System (SANS), a self-contained, externally mountable navigation system. The SANS is designed to determine the location of an underwater object using a combination of Global Positioning System (GPS) while surfaced, and Inertial Navigation System (INS) while submerged. Various experimental testing of the hardware was performed to determine the ability of the GPS navigation system to function within the mission requirements. A test was done to determine the time required to obtain a GPS fix. A test of the system while the antenna was covered with water, was done to determine if the GPS signal could penetrate a shallow layer of water. Finally, a sea test was done to determine the feasibility of reacquiring a GPS fix after the system has been submerged during normal ocean wave wash. A computer simulation was written in Common LISP Object System (CLOS) in order to evaluate the errors introduced by using an accelerometer in the INS to determine the climb angle of the AUV while surfacing. The experimental testing of the GPS system showed that the GPS signal is able to penetrate a shallow layer of water covering the antenna, and that the system is able to meet the accuracy and time requirements of the mission while being splashed by wave wash. The simulation results show that the error introduced by measuring climb angle with an accelerometer is minor and will not significantly degrade the accuracy of the system.

OBJECT-ORIENTED METHODOLOGY FOR MARINE CORPS SOFTWARE DEVELOPMENT

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This thesis answers three questions: What is object-oriented development methodology and why is it good for the Marine Corps? How is object-oriented methodology different from what the Marine Corps is doing now? What should the Marine Corps do and when should they do it? To explore these issue, this thesis designed a typical Marine Corps (a COmpany Personnel System (COPS) using both Systems Development Methodology (SDM) and Object Modeling Technique (OMT). These methodologies are compared in terms of ease of maintenance, understandability, extendibility, inheritance, and database integration. It is good for the Marine Corps because it helps developers and customers express abstract concepts clearly. OMT and SDM differ in their approach to system organization: OMT around real-world objects, while SDM around functionality. The Marine Corps should immediately change its paradigm from SDM to OMT. SDM's Functional Requirements Definition, General Design Specification, and Detailed Design Specification will have to be replaced with OMT's Analysis, System Design, and Object Design respectively.

SOFTWARE FAULT TREE ANALYSIS OF CONCURRENT ADA PROCESSES

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The Automated Code Translation Tool (ACTT) was developed at Naval Postgraduate School to partially automate the translation of Ada programs into software fault trees. The tool works as follows: 1) The Ada parser and lexical analyzer calls the ACTT upon recognition of an Ada statement; 2) The ACTT produces a template representing the statement; 3) The templates are linked together. The tool was lacking in that it only looked at a subset of Ada structures. The problem that this thesis addresses is the implementation of the missing language structures, specifically, concurrency and exception handling, to allow the ACTT to handle all of the Ada structures. The result is a tool that takes the Ada source code and provides the analyst with a sequence of templates, and summary information to assist in incorporating hazard information for generating a fault tree.

INCREMENTAL ON-LINE TYPE INFERENCE

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Type inference in interactive programming environments falls short in two respects. The ability to type-check definitions one at a time, and to type-check some definitions but not all after one definition is modified is called incremental on-line type inference. Current interactive programming environments perform batch type inference and require extensive type recomputation for small changes. We give an algorithm for on-line type inference that is implemented as an attribute grammar. From this grammar an editor was automatically generated that performs on-line type inference. The editor infers types incrementally due to a well-known reduction we used from Hindley-Milner type inference to first-order unification. Unlike other efforts, our algorithm for on-line type inference is truly incremental.

FREE-FIELD SPATIALIZED AURAL CUES FOR SYNTHETIC ENVIRONMENTS

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Commercially available spatial audio systems for synthetic environments suffer from excessive cost and the requirement for in-house application software development The purpose of this work was to develop a low cost audio hardware and software system capable of generating aural cues for a synthetic environment in real-time, which correctly reflects the user's location and accurately conveys the type and location of the sound event. The approach taken was to first implement a software communication package using DIS (Distributed Interactive Simulation protocol, a Department of Defense standard) to retrieve information from the virtual world. The second step was to develop algorithms and software to process that information and model the physical sound world. Finally, an audio hardware system capable of generating the required audio cues in real-time was constructed. The result of this work is a system consisting of software and audio hardware for generating spatial aural cues that correctly localize a sound event for users in a virtual world. The system makes use of "off-the-shelf" audio hardware (MIDI capable sampler, amplifiers, and speakers) which reduces the cost from $20,000 to less than $5,000. With minor modifications for MIDI port access and graphics library function calls, the software can be utilized on any computer that reads DIS packets from the network and writes MIDI data to a data port.

THE DESIGN AND IMPLEMENTATION OF A FUNCTIONAL/DAPLEX INTERFACE FOR THE MULTIMODEL AND MULTILINGUAL DATABASE SYSTEM

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The Multi-Lingual and Multi-Model Database System (MDBS), at the Naval Postgraduate School, is the only database system in which five different database model interfaces operate on a single computer system. The purpose of the MDBS is to prove that multiple database models can coexist and share data within a single computer system. The MDBS provides a platform in which diverse database models can share data, via access to other models' base data, stored in the MDBS common format. The problem was that a Functional database model had not previously been implemented on the MDBS. The goal of this thesis was to provide a Functional DAPLEX interface for the MDBS. The approach was to design and implement a set of programs to encapsulate the Functional/DAPLEX language as introduced by D.W. Shipman in 1981. It is imperative that the interface maintain the look, feel and characteristics of the Functional data model. The results are a set of programs, written in C, which implement a Functional/DAPLEX interface, thus a sixth interface, for the MDBS. The program parses DAPLEX data definition language and data manipulation language constructs, converts them to an MDBS common format, stores the data with other models' base data and can reconvert MDBS common data back to a Functional form.

NETWORK SECURITY AND THE NPS INTERNET FIREWALL

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As the Naval Postgraduate School's (NPS) computer network continues to incorporate computers with a wide variety of security holes, it is vital that an Internet firewall be installed to provide perimeter security holes, it is vital that an Internet firewall be installed to provide perimeter security for NPS from the Internet. NPS has had systems compromised by unauthorized individuals who have gained access via the Internet. The approach taken by this thesis was to analyze the type of Internet firewalls available and chose a design that provides the protection required at NPS while maintaining the Internet functionality desired. After choosing the appropriate type of firewall, it was tested for functionality and performance. The functionality test successfully validated that the bootp, netwall, tftp, sunrpc, and nfsd packets could be blocked while other network services remained functional. The performance testing process first monitored existing traffic to and from the BARRNET and DDN routers. The second step determined the firewall's performance with a well known network measurement tool, New Test TCP/IP *(nttcp)*. The existing data rates to and from the Internet are on average 438 kilobits per second and the *nttcp* tests showed that the firewall could run at 600 kilobits per second. This performance testing validated that the firewall could maintain the data rates currently required to the Internet. This thesis resulted in a firewall, from Texas A&M, that can be installed and used to improve the network security between the NPS network and the Internet. This firewall could run on a PC and would be located between the NPS network and the BARRNET and DDN routers. This would result in a perimeter of security for the NPS network, to assist in the ever growing need for network security.

THROUGHPUT ANALYSIS BETWEEN HIGH END WORKSTATIONS ACROSS AN FDDI NETWORK

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Recently developed high speed networks are capable of transmitting data at rates of 100 Mbps or more. One such network protocol is Fiber Distributed Data Interface (FDDI). This network has a physical transmission rate of 100 Mbps. Analytical and simulation studies have shown that the FDDI protocol should provide actual throughput of 80% to 95% of this physical rate. Can the end user expect to see this kind of performance? If not, then what kind of throughput can actually be expected and where are the bottle necks? In order to answer these and other related questions, two areas were studied: First, a performance comparison between a 40MHz SPARCstation 10 workstation and a 50MHz SPARCstation 10 workstation was conducted using the Neal Nelson commercial benchmark tool. Next, a well-known network measurement tool, ttcp, was used to obtain data transfer rates while varying several tunable operating system and network parameters. The parameters varied were: Target Token Rotation Time, TCP/IP window size, NFS asynchronous threads, Logical Link buffer size and Maximum Transfer Unit size. The results from the commercial benchmark analysis were used to determine if there are any differences which can affect transfer rates between the two workstations. The results from the commercial benchmark tool clearly showed that the newer, higher speed processor is faster. The network tool ttcp showed that the TCP/IP window size had the largest impact on throughput performance. Throughput more than doubles from a window size of 4k to a window size of 20k. This is followed by having more than one workstation transmitting data simultaneously. Having two workstations transmitting nearly halves throughput. This is followed by having a faster processor. A measurement of file transfers using rcp system calls showed that the largest impact on file transfer speed is the overhead of receiving the transferred file.

THE APPLICATION OF ARTIFICIAL-INTELLIGENCE TECHNIQUES TO THE AUTOMATIC IDENTIFICATION OF SOUNDS RECEIVED AT HYDROPHONES AND TO THE CORRELATION OF THESE SOUNDS BETWEEN HYDROPHONES

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The U.S. Navy's Integrated Underwater Surveillance System (IUSS) monitors hydrophones in the northeast Pacific. Geophysics studying the IUSS data find seismic events and correlate them between hydrophones to locate their sources. Marine biologists and intelligence personnel are interested in the identification and localization of other sounds in the IUSS data. The current means of identifying and correlating sounds is a laborious visual examination of the data on a graphics workstation. In this thesis , a computer-vision method is presented for automatically identifying the sources of low-frequency sounds that are received on the IUSS hydrophones. Also presented in this thesis is a blackboard architecture for correlating sound "shapes" between hydrophones using a time-shift transform. The methods in this thesis properly identify approximately 90% of apparent whale moans and 100% of seismic events. The use of the time-shift transform has resulted in nearly a 100% success rate in correlating whale moans between far-field hydrophones, despite marked sound distortions with distance.

AN AUTOMATED TACTICAL OPERATIONS COMMAND, CONTROL, COMMUNICATIONS, AND INTELLIGENCE PLANNING TOOL USING HYPER-NPSNET

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The area of concern addressed by this research is the development of an Automated Tactical Operations Command, Control, Communications, and Intelligence Planning Tool (ATOC^{3}IPT) to aid commanders and their staffs in the decision-making process. The tool is based on Hyper-NPSNET, an application which integrates a single level hypermedia overlay into a 3D virtual world with at most a single instance of each type of multimedia information available at each 3D location. However, Tactical Operations Center (TOCs) require multiple overlays, each with possibly multiple instances of each type of multimedia information available at each location. Also Hyper-NPSNET is a single user system whereas the TOCs require a multiple user system with restricted access. Tactical information display and query retrieval requirements of the command and control organizations were studied. A database structure and control hierarchy were designed. An appropriate graphical user interface (GUI) was developed. The hypersystem used in Hyper-NPSNET was extended to include multiple, permission-protected overlays with multiple instances of each type of multimedia information available at each location. The resulting ATOC^{3}IPT is battlefield planning tool which incorporates today's technology. New hypermedia information display, editing manipulating, and retrieval methodologies not available in Hyper-NPSNET are included. ATOC^{3}IPT is designed to be used by multiple users and with multiple overlays with multiple instances of multimedia information types, whereas in Hyper-NPSNET a single user can work with one single-level overlay. This tool assists the commander in the decision-making process, and provides an excellent training tool for staff officers.

APPLICATIONS OF DIGITAL VIDEO AND SYNTHETIC ENVIRONMENTS TO UNMANNED AERIAL VEHICLES

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The current Army Unmanned Vehicle (UAV) system has two problems, 1) it does not provide for the direct distribution of live UAV video throughout command posts across their local area networks, and 2) it lacks an automated trainer. To solve the video distribution problem, I studies the UAV system, video compression techniques, and local area network protocols to develop the video distribution model. The approach taken for developing the simulator included researching the operational characteristics of the UAV system and studying the creation of synthetic environments. This thesis develops an architecture for extending the distribution of live UAV video inside the command post using a local area network. This architecture specifies bringing UAV video inside the command post via the Joint Surveillance and Target Attack Radar System's (JSTARS) Ground Support Module. Further, it recommends distributing full-motion UAV video over an Asynchronous Transfer Mode (ATM) local area network using the motion Joint Photographic Experts Group (JPEG) compression technique. Additionally, I created an interactive, UAV Simulator using the IRIS Performer applications program interface adn C++. The simulator is implemented using two, networked workstations which replicate the functions of the air vehicle and mission payload operators. The workstations communicate across a local area network using the Distributed Interactive Simulation (DIS) protocol.

DESIGN AND IMPLEMENTATION OF A SOFTWARE COMMUNICATION FOR THE JANUS-3D VISUALIZER

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During the National Guard's mobilization for Desert Shield/Desert Storm, deficiencies were noted in the command and control skills of battalion and brigade level units. The major problem addressed by this research was to improve these skills by developing a software communication architecture that would allow events occurring in two dimensions in the Janus Combat Modeler to be seen in three dimensions on a visualization tool called the Janus-3D Visualizer over both local ethernet and wide area telephonic networks. The challenge was to minimize network latency along with providing accurate data in order to maintain the time and space coherence of the simulation. The approach taken was to first determine where the needed information resided in the Janus modeler. Next, a protocol was developed to extract the information and send it to the Janus-3D Visualizer over the local network for viewing. Finally, a protocol was developed to transmit this information over a telephonic network upon request in order for it to be viewed on a remote Janus-3D Visualizer. As a result of this work, Janus battles can be viewed in three dimensions and in real time by brigade and battalion commanders and their staff without them having to spend valuable training funds to move everyone to a single location. National Guard units can now use the Janus modeler more often and more realistically in order to improve command, control and communication skills.

CREATING A REAL-TIME THREE DIMENSIONAL DISPLAY FOR THE JANUS COMBAT MODELER

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Advisor: David R. Pratt-Department of Computer Science

Several training readiness deficiencies were noted during the mobilization of the National Guard roundout brigades in support of Desert Shield/Storm. One of the areas was the brigade and battalion staff battlefield synchronization skills. National Guard Brigade armories are normally located throughout large geographic areas. Due to the cost and time required to bring all the units to a common training area, this training is conducted only once a year. The problem addressed in this research is to create a visualization tool capable of rendering the Janus combat modeler in a three dimensional environment using scripted files and real time data. The visualization tool must be networked via telephone modems to allow the units to conduct unit training while at their home station. The approach taken was first to design a directory structure that places the terrain files in unique locations that are accessible by the terrain conversion programs and the 3D visualization program. The next step was to create programs to convert the Janus terrain files. Construction of a three dimensional environment capable of displaying real-time information from Janus followed. The last step was to produce an interface for the modem communications and to display that information in real time in the virtual environment. The result is the creation of the Janus-3D Visualizer capable of accurately depicting a Janus scenario running locally or from a remote site. This tool provides commanders with a three dimensional perspective of the battlefield, emplacement of the weapon systems and engagements during a battle.

MODELING OF REAL-TIME DYNAMIC EFFECTS

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Master of Science in Computer Science-September 1994
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Distributed three dimensional combat simulation systems such as the Naval Postgraduate School's NPSNET project lack many of the characteristic effects of the live battlefield. This deficiency is the problem we sought to eliminate. Our approach to solving this absence of effects was to evaluate previous work performed in this area and incorporate aspects of this research that would assist in creating believable effects capable of running in real-time. This thesis focuses on simulating three elements of these war zones - realistic clouds both from an internal and external viewpoint which move due to gridded wind vectors, incorporation of a recording and transmission process for dynamic terrain effects through the implementation of the Distributed Interactive Simulation (DIS) protocol's recently approved Destructible Entity protocol data units (PDUs), and physically-based explosions. The result of this research is a set of effects' simulators available for further studying of and experimenting with modification to these implementations. These programs also provide users with frame rate feedback regarding their modifications to the effects. Furthermore, the cloud implementations and explosive effects are too computationally expensive to be incorporated within complex simulators such as NPSNET.

MASTER OF SCIENCE
IN
ELECTRICAL ENGINEERING

A SIMPLE, LOW OVERHEAD DATA COMPRESSION ALGORITHM FOR CONVERTING LOSSY COMPRESSION PROCESSES TO LOSSLESS

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Advisor: Ron J. Pieper-Department of Electrical and Computer Engineering

In this thesis, a hybrid lossless compression model is tested which employs a combination of both a lossy compression model and one or more lossless image compression methods to produce an overall lossless image compression. The hybrid model decomposes the original image into a browse and a residual image. The hybrid model is tested and evaluated using various combinations of lossy and lossless image compression methods. The lossy compression method used in the model is JPEG (Joint Photographic Experts Group). The lossless compression methods used are Huffman, Arithmetic, LZW, lossless JPEG, and Diagonal coding. The compression results achieved using the hybrid compression model are compared to the compression achieved using the corresponding direct lossless compression. Additionally, the hybrid model is evaluated as to the advantages that the decomposition of the image into browse and residual images provide to the user.

THEORY AND IMPLEMENTATION OF A VLSI STRAY INSENSITIVE SWITCHED CAPACITOR COMPOSITE OPERATIONAL AMPLIFIER

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Master of Science in Electrical Engineering-June 1994
Advisor: Sherif Michael-Department of Electrical and Computer Engineering

In this research, improved analog circuits are implemented using VLSI technology by combining the properties of switched capacitors and composite amplifiers. This combined design solves some of the problems of the single operational amplifier (OA) such as finite dc gain, limited bandwidth and lower slew rate, as well as enhancing the overall network passive and active sensitivities.

For the first time, a theoretical analysis was conducted in a newly-defined discrete transform domain. The analysis was used to justify the circuits that were first designed in the continuous domain and also debug the initial attempts that were made to build an analog chip. The switched capacitor design is implemented using both the toggle switched inverter and the modified open floating resistor techniques. The composite OA is implemented using the C2OA-1 design out of all the CNOA-i possibilities. The two alternatives, together with two single CMOS OAs that were added for comparison reasons, are produced on a single analog/digital microchip. The digital part includes the two-phase non-overlapping clock and programmable switches. It is isolated from the analog part using a low-noise design technique. Sufficient simulations were made to anticipate results in positive and negative finite gain configurations, and also to evaluate the two different techniques.

Finally, neural networks applications of the chip are suggested evoking thoughts for the advantages of this promising technique.

PSPICE SIMULATION OF TOTAL DOSE EFFECTS ON COMPOSITE AND SINGLE OPERATIONAL AMPLIFIERS

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Master of Science in Electrical Engineering-September 1994
Advisor: Sherif Michael-Department of Electrical and Computer Engineering

In this research, continuing evidence that composite operational amplifiers perform better than single amplifiers in both gain bandwidth product and slewrate is presented through an approach of using computer simulation to predict ionizing radiation degradation. This technique examines the use of varying transistor parameters within PSPICE modeled composite and single operational amplifier circuits in order to simulate ionizing radiation. A comparison of the results of this simulation with those of previous research, in which composite and single operational amplifiers were irradiated with a LINAC, verifies that this simulation technique provides a reasonable prediction of a response to ionizing radiation for circuits comprised of radiation hardened components. And, in the process of validating this technique, these simulation results verify that composite operational amplifiers offer an improved bandwidth and a faster slewrate compared to single operational amplifiers.

THE DESIGN AND ANALYSIS OF A PHASED ARRAY MICROSTRIP ANTENNA FOR A LOW EARTH ORBIT COMMUNICATION SATELLITE

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Master of Science in Electrical Engineering-June 1994
Advisor: R.W. Adler-Department of Electrical and Computer Engineering

A Naval Postgraduate School spacecraft design class proposed a multiple beam, phased array, microstrip antenna as part of the preliminary design of a low earth orbit communication satellite. The antenna must provide coverage over the satellite's entire field of view while both uplink and downlink operate simultaneously on the same L-band frequency.

This thesis assesses the feasibility of the antenna proposed in that preliminary design. Design tradeoffs for a microstrip array constrained by both available surface area and a limited mass budget are examined. Two different substrate materials are considered in terms of weight and performance. Microstrip patch theory is applied to array element design and layout and antenna array theory is applied to determine phase and amplitude coefficients. The focus of the design is on obtaining the desired beam shape and orientation, given antenna size constraints. A corporate feed method is discussed and a general design presented.

Antenna performance is predicted through the use of a computer model based on Modal Expansion theory and results are plotted in a series of graphs which demonstrate the limitations of the proposed design.

MULTICAST COMMUNICATION WITH GUARANTEED QUALITY OF SERVICE

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Master of Science in Electrical Engineering-December 1993
Advisor: Shridhar B. Shukla-Department of Electrical and Computer Engineering

In this thesis , we address the problem of constructing multicast data distribution trees with guaranteed quality of service (QoS) for supporting multiparty interactions. We present an approach that integrates reservation with tree construction to facilitate a guaranteed quality of service. The proposed approach is based on the use of information about participants registered before the interaction starts. We first identify the design goals for multicast tree construction with minimum QoS requirements. We then describe a protocol to locate a set of distribution centers for an interaction that depends upon the current load distribution, locations of the participants, and their QoS requirements. The protocol sets up a suitable number of center-specific trees for the interaction transparently. We compare the quality of the resulting trees on large, hypothetical networks with that of sender-specific and Steiner trees. Our results show that center-specific trees, built around the centers located by our approach, reserve fewer resources than sender-specific trees even for a significant number of simultaneous senders while sacrificing minimally in the average delay faced by each receiver.

SPACE TETHER - RADAR DATA PROCESSING

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Master of Science in Electrical Engineering-September 1994
Master of Science in Applied Physics-September 1994
Advisors: Ralph Hippenstiel-Department of Electrical and Computer Engineering and
Richard C. Olsen-Department of Physics

NASA conducted the Delta-PMG tethered satellite mission. It was conducted to verify the hollow cathode plasma source's ability to couple electric currents from each end of a long wire tether traversing the ambient low earth orbit ionosphere plasma. Observations were obtained through a suite of sensors which included large ground radar based in Hawaii to study disturbances in the Earth's ionosphere caused by the tether. After extensive analysis, unique radar returns were identified that were associated with the passage of the tether system through magnetic field lines threading the radar's field of view. These returns were interpreted as a plasma cloud propagating along a magnetic field line and reflecting back along another. This phenomenon produced dual returns with inverted Doppler frequency content.

NODE TO PROCESSOR ALLOCATION FOR LARGE GRAIN DATA FLOW GRAPHS IN THROUGHPUT-CRITICAL APPLICATIONS

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Master of Science in Electrical Engineering-June 1994
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This thesis describes issues involved in node allocation for a Large Grain Data Flow (LGDF) model used in Navy signal processing applications. In the model studied, nodes are assigned to processors based on load balancing, communication/computation overlap, and memory module contention. Current models using the Revolving Cylinder (RC) technique for LGDF graph analysis do not adequately address node allocation. Thus, a node to processor allocation component is added to a computer simulator of an LGDF graph model. It is demonstrated that the RC technique, when proper node allocation is taken into account, can improve overall throughput as compared to the First-Come-First Served (FCFS) technique for high communication/ computation costs.

WAVEFORM GENERATION FOR ULTRA-WIDEBAND RADAR SYSTEM

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In the current literature, ultrawide band (UWB) waveforms are said to possess several potential advantages such as penetration of foliage, walls, ground as well as target identification and detection of stealth targets. Due to the potential advantages of UWB waveforms, UWB power sources are currently being developed. Unlike the traditional high voltage pulse generators, this thesis investigates Fourier synthesis method of waveform generation which is to be used with ultrawide band radar. The major advantages of this method over traditional methods are that accurate control of pulse shapes and repetition intervals (PRI) can be generated. In this thesis, the Fourier method is extended to generation of binary coded waveforms for UWB systems. The generation of such codes is important as it allows for the use of longer coded pulses. These coded pulses hold more energy and improve signal to noise ratio (SNR) while still retaining the range resolution and other benefits of smaller pulse width.

ERROR PROBABILITIES OF FFH/BFSK WITH NOISE NORMALIZATION AND SOFT DECISION VITERBI DECODING IN A FADING CHANNEL WITH PARTIAL-BAND JAMMING

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An error probability analysis of a communications link employing convolutional coding with soft decision Viterbi decoding implemented on a fast frequency-hopped, binary frequency-shift keying (FFH/BFSK) spread spectrum system is performed. The signal is transmitted through a frequency non-selective, slowly fading channel with partial-band jamming. Noise normalization combining is employed at the receiver to alleviate the effects of partial-band jamming. The received signal amplitude of each hop is modeled as a Rician process, and each hop is assumed to fade independently.

It is found that with the implementation of soft decision Viterbi decoding that the performance of the receiver is improved dramatically when the coded bit energy to partial-band noise power spectral density ratio (E_b/N_I) is greater than 10dB. At higher E_b/N_I, the asymptotic error improves dramatically and varies from 10^{-6} to 10^{-12} depending on the constraint length (v), number of hops/bit (L), and the strength of the direct signal ($a^2/2o_2$). In addition, nearly worst case jamming occurs when the jammer uses a full band jamming strategy, even when L=1 and when there is a very strong direct signal ($a^2/2o^2 = 100$). Due to non-coherent combining losses, when the hop per bit ratio is increased, there is some degradation at moderate E_b/N_I. Furthermore, when a stronger code is used (i.e. the constraint length is longer), performance improves, especially for high E_b/N_I where the asymptotic error is reduced. Finally, soft decision decoding improves performance over hard decision decoding from 4 to 8dB at moderate E_b/N, depending on the code rate and with a much lower asymptotic error at high E_b/N_I.

INVESTIGATION OF SPECTRAL-BASED TECHNIQUES FOR CLASSIFICATION OF WIDEBAND TRANSIENT SIGNALS IN ADDITIVE WHITE GAUSSIAN NOISE

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Master of Science in Electrical Engineering-1994
Advisor: R. Hippenstiel-Department of Electrical and Computer Engineering

Spectral-based classification schemes designed to separate various wide band transient signals in added noise have been identified and their performances compared along with those obtained using a back-propagation neural network implementation. The spectral-based measures used include: the normalized cross-correlation coefficient; the modified normalized cross-correlation coefficient, and; the divergence and the Bhattacharyya distance. Noise was added to the signals to create signal to noise ratios of 0 dB to -20 dB. Results show that as noise levels increase, the modified normalized cross-correlation coefficient spectral measure remains the most robust scheme.

SPEECH RECOGNITION OF FOREIGN ACCENT

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B.S., Wright State University, 1985
Master of Science in Electrical Engineering-June 1994
Advisors: M.P. Fargues and R. Hippenstiel-Department of Electrical and Computer Engineering

This thesis investigates the application of AutoRegressive (AR) modeling techniques on single syllable words to detect foreign accents in spoken American English. The study involves thirty-one native American English speakers, and six native Brazilian speaker. Five different distance measures are used for classification. Results show that correct classification is obtained for 88% of the native English speakers and 80.5% of the non-native (foreign) English speakers.

A VLSI INTERFACE FOR THE NM24CF04 SERIAL-ACCESS FERROELECTRIC MEMORY

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Master of Science in Electrical Engineering-March 1994
Advisor: Douglas J. Fouts-Department of Electrical and Computer Engineering

The goal of this research project was to design a VLSI implementation of the required digital circuitry to utilize ferroelectric memory as a portion of main microprocessor memory. An interface between National Semiconductor's NM24CF04, a nonvolatile, serial-access, ferroelectric memory device, and Intel's 8086 microprocessor was designed and implemented in a previous study. This thesis discusses the redesign of the previously designed circuit for VLSI implementation. The layout was accomplished using the Magic graphical layout editor and tested using the Esim event driven logic-level simulator.

A NON-LINEAR STUDY OF THE GAIN MARGIN OF A THIRD ORDER REGULATOR SYSTEM

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Master of Science in Electrical Engineering-December 1993
Advisor: Papoulias Fotis-Department of Mechanical Engineering

This thesis analyzes the dynamic response of a third order regulator system. Particular emphasis is placed upon the loss of stability of the nominal equilibrium state. The system utilized in research models the fundamental turning dynamics of an autonomous vehicle. We make extensive use of bifurcation theory methods in analyzing the dynamics after initial loss of stability. The effective gain of the system is used as the main bifurcation parameter, since this is directly related to the gain margin for linear systems. It is shown that the nonlinear characteristics of the system may significantly affect the practical significance of its gain margin, as a measure of robustness to parameter variations, unmodeled dynamics, and external disturbances.

DESIGN AND MODELING OF A LINK MONITORING MECHANISM FOR THE COMMON DATA LINK (CDL)

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Master of Science in Electrical Engineering-September 1994
Advisor: Shridhar B. Shukla-Department of Electrical & Computer Engineering

The Common Data Link (CDL) is a full duplex, point-to-point microwave communications system used in imagery and signals intelligence collection systems. It provides a link between two remote Local Area Networks (LANs) aboard collection and surface platforms. In a hostile environment, thre is an overwhelming need to dynamically monitor the link and thus, limit the impact of jamming. This work describes steps taken to design, model, and evaluate a link monitoring system suitable for the CDL. The monitoring system is based on features and monitoring constructs of the Link Control Protocol (LCP) in the Point-to-Point Protocol (PPP) suite. The CDL model is based on a system of two remote Fiber Distributed Data Interface (FDDI) LANs. In particular, the policies and mechanisms associated with monitoring are described in detail. An implementation of the required mechanisms using the OPNET network engineering tool is described. Performance data related to monitoring the parameters is reported. Finally, integration of the FDDI-CDL model with the OPNET Internet model is described.

AN ANALOG PREPROCESSING ARCHITECTURE FOR HIGH-SPEED ANALOG-TO-DIGITAL CONVERSION

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Master of Electrical Engineering-December 1993
Advisor: P.E. Pace-Department of Electrical and Computer Engineering

This thesis investigates the feasibility of implementing an analog-to-digital converter (ADC) based on a new symmetrical number system (SNS). This preprocessing architecture decomposes the analog amplitude analyzing function of an ADC into a number of sub-operations (moduli). Each sub-operation folds the analog signal with a folding period proportional to the value of the modulus. Through the use of the SNS encoding and recombining the results of the sub-operations, a definitive performance enhancement is achieved. The number of comparators required is reduced considerably, allowing more bandwidth to be used in the folding circuits. The overall design effort demonstrates a 9-bit design with a total of 23 comparators. SPICE simulations are developed and the performance demonstrated. Also identified are the areas in which further research is required.

INBAND RADAR CROSS SECTION OF PHASED ARRAYS WITH PARALLEL FEEDS

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B.S.E.E. equivalent Naval Postgraduate School, 1993
Master of Science in Electrical Engineering-June 1994
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Approximate formulas for the inband radar cross section of arrays with parallel feeds are presented. To obtain the formulas, multiple reflections are neglected, and devices of the same type are assumed to have identical electrical performance.

The approximate results were compared to the results obtained using a scattering matrix formulation. Both methods were in agreement in predicting RCS lobe positions, levels, and behavior with scanning. The advantages of the approximate method are its computational efficiency and its flexibility in handling an arbitrary number of coupler levels.

PRELIMINARY FLIGHT SOFTWARE SPECIFICATION FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

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PANSAT is a small, spread-spectrum, communications satellite under design at the Naval Postgraduate School. It will support a store and forward bulletin board system for use by the amateur radio community. The flight software is responsible for the autonomous telemetry collection and hardware control operations of the satellite, communications and file transfer protocols allowing access to the bulletin board system, and command interpretation and response to ground control commands.

In this thesis, the complete flight software architecture and module interfaces are specified using the Estelle Format Description Technique. The module bodies dealing with communications and file transfer protocols are specified in detail in Estelle. The current design goals for the remainder of the flight software modules are discussed. Appendices include the preliminary flight software specification itself, a data flow diagram interpretation of the specification, and a summary of the Estelle syntax used.

IMPROVING TRANSIENT SIGNAL SYNTHESIS THROUGH NOISE MODELING AND NOISE REMOVAL

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Master of Science in Electrical Engineering-March 1994
Advisor: Charles W. Therrien-Department of Electrical and Computer Engineering

This thesis examines signal modeling techniques and their application to ambient ocean noise for purposes of noise removal and for generating realistic synthetic noise to add to synthetically generated transient signals. Higher order statistics of the noise are examined to test for Gaussianity. Stochastic approaches to AR, MA, and ARMA modeling are compared to see which technique yields the "best" synthetic noise. Results from the modeling process are used to develop a short-time Wiener filter which can be used to condition a real a signal for further processing through effective noise removal.

HI FI DIGITAL AUDIO TAPE TO SUN WORKSTATION TRANSFER SYSTEM FOR DIGITAL AUDIO DATA

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This thesis describes a subsystem developed to provide for the transfer of digital audio signals from a SUN SPARCstation 10 workstation to a digital audio tape (DAT) and vice versa. The new system expands the audio recording/reproduction options available in the laboratory by integrating an analog tape deck and a digital tape deck with the SUN workstation. The desired connection enables working with a larger audio bandwidth to achieve better audio performance and resolution in comparison to the present workstation audio capabilities. Performance measurements of the audio signal-to-noise ratio have shown an improvement of about 45 dB in the audio reproduction capability and about 35 dB in the audio recording capability. Total harmonic distortion for the new system is below the limit of the measuring instrumentation (less than 0.1%).

EXPERIMENTAL HARDWARE DEVELOPMENT FOR A PULSED ULTRASONIC DATA COLLECTION FACILITY

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Master of Science In Electrical Engineering-June 1994
Advisor: John P. Powers-Department of Electrical and Computer Engineering

The work reported in this thesis used readily available components to implement a data acquisition system for a pulsed ultrasonic data collection facility. Use of hardware with controlling software is necessary to collect waveforms of acoustic potential at a given distance from the transmitting source. Precise movement and positioning of an acoustic receiver in the collection plane is accomplished by use of an xy coordinate motor-driven slide assembly. A signal generator and transmit digitizer transient and digitize the signal, respectively. These components are brought together synchronously using Lab VIEW instrumentation software. This work provides an efficient means to collect waveform data which can be used to verify computer code written previously for the purpose of modeling pulsed ultrasonic acoustic diffraction patterns.

AN ANALYSIS OF THE EFFECTS OF FEEDLINE AND GROUND SCREEN NOISE CURRENTS ON A CONICAL MONOPOLE ANTENNA

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Excessive electromagnetic interference/radio frequency interference (EMI/RFI) degrades the capability of the Naval Security Group (NSG) high frequency direction finding (HFDF) sites to receive signals of interest (SOI). These sites use a circularly disposed antenna array (CDAA) to receive signals in the 2 to 30 MHz frequency range. A conical monopole (CM), an antenna whose bandwidth matches the CDAA's, may provide a solution to the EMI/RFI problem through separation and isolation. Semi-remotely locating the CM away from EMI/RFI sources achieves the former, while its independence from the noisy RF distribution system accomplishes the latter. This thesis analyzed the susceptibility of the CM to EMI/RFI currents that might be injected onto the feedline from equipment in the building at the center of the CDAA.

The Numerical Electromagnetics Code (NEC) was used to model the CM and its buried feedline at the Imperial Beach CDAA site. The numerical model was used to validate proposed limits for the maximum allowable EMI/RFI current on incidental conductors and grounds at receiving sites. A maximum of two microamps of EMI current has been suggested to ensure that no appreciable degradation of SOI reception occurred. The NEC CM model predicted that the two microamp current limit would be adequate for SOI reception on the CM examined. Experimental measurements obtained at the Imperial Beach HFDF site partially validated these results and demonstrated that the CDAA response to the two microamp EMI/RFI limit is within the expected levels.

PROBABILITY OF DETECTION FOR A GO CFAR RADAR PROCESSOR USING AN ENVELOPE DETECTION APPROXIMATION

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Master of Science in Electrical Engineering-September 1994
Advisor: Phillip E. Pace-Department of Electrical & Computer Engineering

The greatest-of logic for a constant false alarm rate processor (GO CFAR) is a commonly used method for the adaptive setting of a radar detectio threshold in the presence of clutter edges. Instead of using a true envelop detector $x = \sqrt{I^2+Q^2}$ which is difficult to implement, envelope detection approximations of the form $x_e = aMax\{|I|, |Q|\} + bMin\{|I|, |Q|\}$ *and* $x_e = a|I| + b|Q|$ (no *Max* and *Min* operators) where a and b are constants, are often used to detect a signal decomposed into its in-phase (I) and quadrature (Q) components. Closed form expressions are derived for the probability density function (pdf) of a radar range cell containing a detected target signal in the presence of noise using both approximations. These can then be used to calculate the probability of detection (P_D). They can also be used to calculate the probability of false alarm (P_{FA}) if the means of I and Q are set to zero. Closed form expressions are obtained analytically and by curve-fitting the numerically derived pdf of the target cell. Finally, using Monte Carlo techniques, this thesis also compares the GO CFAR detection performance using envelope detection approximations x_e,x_e and the tru envelope detector x for zero mean white Gaussian noise input samples I and Q.

INTERMEDIATE DESIGN AND ANALYSIS OF THE PANSAT ELECTRICAL POWER SUBSYSTEM

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Master of Science in Electrical Engineering-March 1994
Advisor: Robert Ashton-Department of Electrical and Computer Engineering

This thesis examined three primary components of the electrical power subsystem (EPS) for the Petite Amateur Navy Satellite (PANSAT): (1) the solar array; (2) the power conditioning and control subsystem (PCCS); and (3) the batteries. The emphasis of this thesis was to analyze the output performance of the solar array. Additionally, the derivation of the hybrid PCCS proposed for the EPS was examined and the use of Nickel-Cadmium batteries as a candidate for the secondary power source was discussed. The investigation of the solar array's output performance led to PANSAM (PANSAT Solar Array Model), a computer model which simulates the power output of the solar array. The user can specify the sun's declination, the orbit's inclination, and the satellite's orientation and rate of rotation about each of its three axes. Once a simulation is complete, PANSAM provides the effective surface area illuminated by the sun, and the output current and power. The average effective area determined by PANSAM was 17.6% less than the 1259 cm^2 originally proposed by the PANSAT staff. This contributed to a substantial reduction in predicted power. A preliminary transient thermal analysis of PANSAT was also conducted to provide temperature data for PANSAM.

DESIGN AND SYNTHESIS OF A REAL-TIME CONTROLLER FOR AN UNMANNED AIR VEHICLE

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Master of Science in Electrical Engineering-September 1994
Master of Science in Computer Science-September 1994
Advisor: Michael K. Shields-Department of Electrical & Computer Engineering and
Se-Hung Kwak-Department of Computer Science

The Naval Postgraduate School is developing a vertical take-off and landing (VTOL) unmanned air vehicle (UAV) that can transition to horizontal flight, once airborne, in order to take advantage of the improvements in speed, range, and loiter time that horizontal, fixed-wing flight provides. This research investigates the design requirements of the central controlling device for that UAV, including the specific problems of defining th enecessary hardware components and developing software for executive control. First, hardware requirements needed to be determined. By exploring th egeneral operational requirements of the UAV and taking into account space and weight limitations, a hardware suite was selected which could provide adequate functionality to replace the human traits of a pilot. In order to provide "awareness" of the operational environment, motion sensors, navigation equipment, and communication equipment was required. Controllable servo motors were necessary to move control surfaces appropriately. Computer hardware, necessary to provide system intelligence, was selected in order to interoperate with the other hardware. Next, a Real-Time Executive (RTE) software program was designed to provide the functionality and coordination of all hardware components. Device drivers for each component were developed, and overall coordination was planned using a Yourdon style essential model. Periodic interrupts were used to control execution time. Last, the specifications and configuration of all hardware components were completely documented, and the operation of the RTE program is fully explained. From this understanding of the overall control system, future development can continue, resulting in a more effective and efficient UAV design.

REMOTE SENSING, PROCESSING AND TRANSMISSION OF DATA FOR AN UNMANNED AERIAL VEHICLE

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B.S., University of Kansas, 1988
Master of Science in Electrical Engineering-June 1994
Advisor: Michael K. Shields-Department of Electrical and Computer Engineering

This thesis chronicles the development of a proof-of-concept, and stand-alone, Unattended Ground Sensor (UGS) that can be used to sense and process signals associated with the motion of large vehicles, troops, or aircraft. The results of this signal processing are then transmitted to an Unmanned Aerial Vehicle (UAV). The UGS uses acoustic and seismic sensors to provide data to a Digital Signal Processing (DSP) computer. Digital signal processing algorithms can be independently developed in the C programming language and linked with the software developed for this project.

THE AMBIGUITY FUNCTION OF THE STEPPED FREQUENCY RADAR

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Master of Science in Electrical Engineering-September 1994
Master of Science in Systems Engineering-September 1994
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High range resolution radar systems have many advantages such as target classification, resolution of multiple targets, accurate range measurement, target range profile and detection of low radar cross section (RCS) targets in clutter. High range resolution requires large bandwidths. Stepped frequency waveforms can achieve high range resolution by increasing the effective bandwidth without increasing the instantaneous bandwidth which would increase the hardware requirements including higher analog to digital (A/D) sampling rates which are limited by existing technology. Under today's hardware limitations, the stepped frequency waveform becomes very important. This thesis briefly discusses the stepped frequency radar and associated signal processing, it investigates the ambiguity function of the stepped frequency waveform and the stepped frequency radar system. Mathematical expressions of ambiguity functions are derived and the improvement of clutter suppression capability for the stepped frequency radar by rejecting initial pulses is also discussed.

A GALLIUM ARSENIDE MESFET OPERATIONAL AMPLIFIER FOR USE IN COMPOSITE OPERATIONAL AMPLIFIERS

Benjamin L. Hudson-Captain, USA
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Master of Science in Electrical Engineering-December 1993
Advisor: Sherif Michael-Department of Electrical and Computer Engineering

A gallium arsenide (GaAs) MESFET operational amplifier for use in composite operational amplifier (CNOA) configurations is described. This advice is guaranteed to be suitable for construction in CNOA models. The GaAs op amp design is a general-purpose device that exhibits a low-frequency gain of approximately 32dB and an open-loop unity gain frequency of 1.3GHz. The input offset voltage of the op amp is 20mV. These parameters are essential for optimum composite operational amplifier performance. Development and simulation of the GaAs op amp is presented.

PERFORMANCE OF A FAST FREQUENCY-HOPPED NONCOHERENT MFSK RECEIVER WITH NON-IDEAL NOISE NORMALIZATION COMBINING OVER RICEAN FADING CHANNELS WITH PARTIAL-BAND INTERFERENCE

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Master of Science in Systems Engineering-September 1994
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An error probability analysis is performed for a noncoherent M-ary orthogonal frequency-shift keying (MFSK) communication system employing fast frequency-hopped (FFH) spread spectrum. The signal is assumed to be transmitted through a frequency-nonselective, slowly fading channel with partial-band interference. The partial-band interference is modeled as a Gaussian process. The noise-normalized receiver is employed to minimize partial-band interference effects, and the effect of inaccurate noise measurement on the ability of the noise-normalized receiver to reject partial-band interference is examined. Each diversity reception is assumed to fade independently according to a Ricean process. Thermal noise is also included in the analysis. It is found that diversity dramatically reduces the degradation due to partial-band interference, and noise measurement error does not significantly degrade receiver performance. The robustness of the receiver with regard to noise measurment error is independent of the strength of channel fading.

ADAPTIVE CONTROL FOR A SPACECRAFT ROBOTIC MANIPULATOR

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This research involves the development of an adaptive control law for a space based two-link robotic manipulator. Non-adaptive controllers are first obtained utilizing feedback linearization techniques. A direct adaptive controller is then developed through the linear parameterization of the system dynamics, and the implementation of a Kalman Filter based adaption law. The controllers are then simulated and compared for various levels of system parameter uncertainty. The adaptive controller is found to be superior to the non-adaptive controllers for high levels of system parameter uncertainty. The non-adaptive controller is found to compare favorably to the adaptive controller in some areas for low values of system parameter uncertainty. The non-adaptive controller is implemented experimentally, consistent with hardware constraints. Experimental results verify the need for adaptive control when system dynamics are present which have not been modelled.

LINEAR QUADRATIC GAUSSIAN CONTROLLER DESIGN USING LOOP TRANSFER RECOVERY FOR A FLEXIBLE MISSILE MODEL

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In this thesis, a Linear Quadratic Gaussian Controller (LQG) is designed for a tail controlled surface-to-air missile model in order to meet design specifications. The mathematical model of the flexible missile is subject to uncertainties that may arise from unmodelled dynamics, parameter variation of linearization of nonlinear elements. Since these uncertainties are not taken into account in the LQG controller, u Analysis is applied to the design in order to evaluate the Robust Performance, Robust Stability, and Nominal Performance of the system. Finally, a Linear Quadratic Gaussian controller is designed using Loop Transfer Recovery (LQDLTR) in order to improve the Robust Stability of the system. It is found that the Robust Stability of the design is improved, but as a consequence of losing nominal performance. The u Analysis and Synthesis Toolbox and the Control Toolbox of MATLAB were used for the design, assembly, analysis and simulation of the missile flight control system.

DATA LINK LEVEL INTERCONNECTION OF REMOTE FIBER DISTRIBUTED DATA INTERFACE LOCAL AREA NETWORKS (FDDI LANs) THROUGH THE CRITICAL DATA LINK

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This thesis deals with the features and performance of a network interface device to interconnect two remote Fiber Distributed Data Interface (FDDI) Local Area Networks (LANs) through the Critical Data Link (CDL) which is a full-duplex, jam-resistant, point-to-point microwave communications system for use in imagery and signals intelligence collection systems. In particular, OPNET, a commercially available network engineering tool is used to model a medium access level remote bridge interface connecting two LANs. The effectiveness of two different load balancing techniques used to distribute traffic over the multiple channels of the CDL has been studied. Also, the effect of different jamming patterns on the bit error rate seen by the users has been studied.

A MODULAR APPROACH TO MODELING AN ISOLATED POWER SYSTEM ON A FINITE VOLTAGE BUS USING A DIFFERENTIAL ALGEBRAIC EQUATION SOLVING ROUTINE

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The modeling of power systems has been primarily driven by the commercial power utility industry. These models usually involve the assumption that system bus voltage and frequency are constant. However, in applications such as shipboard power systems this infinite bus assumption is not valid. This thesis investigates the modeling of a synchronous generator and various loads in a modular fashion on a finite bus. The simulation presented allows the interconnection of multiple state-space models via a bus voltage model.

The major difficulty encountered in building a model which computes bus voltage at each time step is that bus voltage is a function of current derivative terms. Bus voltage is also an input to the state equations which produce the current and current derivatives. This creates an algebraic loop which is a form of implicit differential equation.

A routine has been developed by Linda Petzold of Lawrence Livermore Laboratory for solving these types of equations. The routine, called DASSL (Differential/Algebraic System Solver), has been implemented in a pre-release version of the software ACSL (Advanced Continuous Simulation Language) and has been made available to Naval Postgraduate School on a trial basis. An isolated power system is modeled using this software and the DASSL routine. The system response to several dynamic situations is studied and the results are presented.

GRAPHICAL MODELING OF SHIPBOARD ELECTRIC POWER DISTRIBUTION SYSTEMS

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With the increasing application of power electronics to shipboard electric power systems, there is a need for studying power systems in an object-oriented, graphical environment in order to examine the interrelations of the various system components.

This thesis presents a method of analyzing shipboard electric power systems in a graphical environment. The simulation method used allows for real-time observation of the various power system measurements of interest.

The machine equations, including those for voltage, torque, and rotor angle are developed which permit analyzing the machine in any chosen reference frame depending on the study being undertaken. Regulators for both speed and field voltage are developed and the stability of the speed regulator is examined. A means of modeling a load for a synchronous generator is then shown which accurately interrelates the loading of the generator and the frequency and voltage output of the machine. This load is then connected to the synchronous generator and two different scenarios are examined, including a fifty load change and a faulty study. Graphs showing the output of these studies are presented.

SCALABLE MULTICAST TREE CONSTRUCTION FOR WIDE AREA NETWORKS

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In this thesis, we address the problem of multicast tree construction with guaranteed quality of service (QoS) in networks with asymmetric link costs. We describe a protocol to locate distribution centers for an interaction based on network load and participant location. We then describe the protocol for constructing a shared tree around the selected center. We compare the quality of the resultant trees on large hypothetical networks with that of source based trees. Additional comparisons are made with other multicast techniques such as Protocol Independent Multicasting (PIM) and Core Based Trees (CBT). Our results show that the shared trees built using our approach reserve fewer resources than the source based trees even for a significant number of simultaneous senders. The shared trees built using our approach represent a significant improvement over other techniques when the network topology contains a large degree of asymmetry in link costs. This makes our approach the most general of all other techniques proposed to date.

THE EFFECT OF RICIAN FADING AND PARTIAL-BAND INTERFERENCE ON NOISE-NORMALIZED FAST FREQUENCY-HOPPED MFSK RECEIVERS

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The performance of an M-ary orthogonal frequency-shift keying (MFSK) communication system employing fast frequency-hopped spread spectrum waveforms transmitted over a frequency-nonselective, slowly fading channel with partial-band interference is analyzed. A procedure referred to as noise-normalization combining is employed by the system receiver to minimize partial-band interference effects. Each hop is assumed to fade independently. The partial-band interference is modeled as a Gaussian process. Both the signal and the partial-interference are assumed to be affected by the fading channel which is modeled as Rician. The effect of fading of the partial-band interference on worst-case receiver performance is relatively minor. When there is no signal fading or when the signal fading is Rician, then the counter-intuitive result of poorer receiver performance when the partial-band interference experiences fading is obtained. This effect is most pronounced when the signal does not fade and the partial-band interference experiences Rayleigh fading.

ANNEALING OF RADIATION DAMAGED GALLIUM ARSENIDE SOLAR CELLS BY LASER ILLUMINATION

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In this research, preliminary results of a new approach for annealing previously irradiated Gallium Arsenide solar cells is reported. This technique examines the use of laser illumination to induce Forward-Biased current annealing. Five GaAs solar cells were irradiated with 65 MeV electrons at varying fluence levels. Visible laser light produced a 0.5 a/cm^2 forward-biased current density and raised the solar cell temperature by 30°C. Ten to fifteen percent recovery of degraded parameters was achieved in four of the five tested cells. The results show that a laser can produce some annealing in radiation damaged GaAs solar cells. Further investigation into the results also indicate that the 65 MeV energy level of the electron irradiation could have caused unrecoverable permanent damage to the solar cells. Follow up research of this annealing technique should be conducted on GaAs cells that are being irradiated at a lower energy level as well as lower fluence level. Repetitive annealing of lightly damaged cells in previous research has provided appreciative recovery using forward bias current techniques. One can expect similar results using the laser induced annealling technique proposed in this research.

ANALYSIS OF DIRECT DETECTION LIGHTWAVE SYSTEMS WITH OPTICAL AMPLIFIERS

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We provide a detailed analysis of direct detection lightwave systems employing an optical preamplifier at the receiver and derive the closed form expression for the bit error probability of WDM systems employing on-off keying (OOK) as the modulation format. In our analysis, we consider various cases in which the receiver model uses either a finite-time integrator or Fabry-Perot filter operating in a single channel or multi-channel environment. We take into account the optical amplifier noise, the postdetection receiver noise, the shot noise, and the effect of the nonzero laser linewidth.

KALMAN FILTERING APPROACH TO BLIND EQUALIZATION

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Digital communication systems suffer from the channel distortion problem which introduces errors due to intersymbol interference. The solution to this problem is provided by equalizers which use a training sequence to adapt to the channel. However in many cases in which a training sequence is unfeasible, the channel must be adapted blindly. Most of the blind equalization algorithms known so far have problems of convergence to local minima. Our intention is to offer an alternative approach by using extended Kalman filtering and hidden Markov models. They seem to yield more efficient algorithms which take the statistics of the transmitted sequence into consideration. The theoretical development of these new algorithms is discussed in this thesis. Also these algorithms have been simulated under different conditions. The results of simulations and comparisons with existing systems are provided. The models for simulations are presented as MATLAB codes.

GENERATION OF THE AMBIGUITY FUNCTION FOR ULTRAWIDEBAND RADAR WAVEFORMS

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The Ambiguity Function is one of the tools used to study the suitability of waveforms for radar applications. An understanding of this function gives the radar engineer an insight into different radar waveforms and permits him to select the best design for a particular system application. This thesis investigates the Ambiguity Function for ultrawideband radar waveforms generated by the Fourier Synthesis Method, which provides the capability to produce very narrow pulses in a coherent and controllable form. Since, for ultrawideband radar waveforms, the transmitted signal is a baseband signal without sinusoidal carrier, the Ambiguity Function for this kind of waveform should be generated by Doppler processing in the time domain rather than in the frequency domain, as is done for conventional radar waveforms. In this thesis, the Ambiguity Function has been generated and analyzed for two different ultrawideband radar waveforms by means of computer simulation of a radar receiver which incorporates time-Doppler processing.

A PLATFORM INDEPENDENT APPLICATION OF LUX ILLUMINATION PREDICTION ALGORITHMS

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Naval Aviators require prior knowledge of the time and location of astronomical phenomena in order to properly plan and execute combat and training operations during the hours of darkness using Night Vision Devices (NVD's) . This thesis presents a computer application of illumination prediction algorithms which predict the time of selected astronomical phenomena. This computer program is platform independent (given the proper libraries), event-driven, object-oriented, and utilizes a Graphical User Interface (GUI). Using this application, operators in the field will be able to determine the time of selected phenomena and the quantity of illumination, measured in Lux, for a given time and date.

PRELIMINARY DIGITAL CONTROL SYSTEM DESIGN FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

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The Petite Amateur Navy Satellite (PANSAT) project was initiated to demonstrate the feasibility of a quick - reaction, low cost communications satellite incorporating digital communications and a store and forward memory area for the use of amateur radio operators interested in spread spectrum and packet communications. Designed to operate autonomously and under the guidance of a ground station located at the Naval Postgraduate School (NPS) in Monterey, California, it requires a reliable Digital Control System (DCS) to control operations while processing communications and telemetry.

This thesis deals with a preliminary hardware design for the DCS and related subsystems. In addition to the design process, individual components were selected which were deemed suitable for the space environment while operating under project constraints of limited power and a desire to create a system using off-the-shelf devices capable of handling temperature and physical constraints equivalent to MIL-STD-883. Reliability, redundancy, and flexibility were requirements of the DCS design.

FAULT DETECTION AND ISOLATION FOR THE BLUEBIRD TEST BED AIRCRAFT

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A Fault Detection and Isolation (FDI) algorithm design is presented using the Multiple Model algorithm technique for the Bluebird aircraft being developed at the Naval Postgraduate School. The requirement to maintain high performance in the dynamic system of the aircraft necessitates the use of FDI techniques to detect and isolate malfunctions in the sensors and actuators of the aircraft without using hardware redundancy. The solution presented makes use of analytical redundancy in a bank of Kalman filters. Statistical tests using Bayesian theory are applied on the filter's innovations to perform the task of detection and isolation. The algorithm was developed using MATLAB software from The Math Works, Inc. The work presented in this thesis is related only to the task of FDI. The remaining task of the monitoring system, reconfiguration and continued operation by the observed plant after a failure detection, will not be addressed.

PREDICTING ANTENNA PARAMETERS FROM ANTENNA PHYSICAL DIMENSIONS

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This report details the development and provides the documentation for custom computer software applications that evaluate antenna parameters. The applications are written in Mathcad 3.1 for the following antenna types: linear, planar, and circular arrays; folded dipole; caged dipole; parabolic reflectors with helical and spiral feeds. Inputs to the applications are limited to the antenna's physical dimensions. In some cases, ground parameters are required.

The chapters are structured to provide the user with the necessary information needed to use and interpret the software for each antenna type. The software applications are provided as appendices and give examples of each antenna type.

Outputs of the applications provide various numerical and performance predictions, as well as far-field radiation patterns. The results computed are consistent with predictions provided in applicable publications, as well as those calculated by numerical antenna analysis programs such as ELNEC.

DOPPLER SHIFT AND SPREAD STUDY FOR IONOSPHERICALLY PROPAGATED SIGNALS

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Modern, High Frequency (HF) communication techniques, such as spread spectrum and frequency hopping, require precise signal frequency information. The predominant HF propagation path is via the ionosphere, which often produces Doppler frequency shift and spread. This study examined the frequency spectra of selected HF signals traversing short and long mid-latitude paths and one high-latitude auroral zone path. Signal amplitude and Doppler shifts and spreads observed show diurnal, carrier frequency and ionospheric path dependencies. Higher frequency signals experienced more Doppler shift, especially during the daytime. Spectrum spreading was more pronounced at night and was affected by multiple reflections, the auroral oval and field-aligned ionization. Additional signal observations are needed to cover seasonal variations, disturbed ionospheric conditions and solar cycle variations. The impact of Doppler shift and spread on wide-spectrum HF communications also needs to be examined.

SIGNAL PROCESSING FOR THE 1992 BARENTS SEA TOMOGRAPHY EXPERIMENT

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In August 1992, an acoustic tomography experiment was conducted in the Barents Sea. The objective of this thesis is the development of space-time signal processing algorithms to extract the arrival times of rays and modes for that experiment. The temporal signal processing involves pulse compression of the phase-encoded signal. Spatial signal processing consists of plane wave and modal beamforming on data from a 16 element vertical line array. After signal processing an arrival detection, identification, and tracking algorithm is used to obtain travel time and travel time error estimates. After development and testing of these algorithms, 13 hours of acoustic data was processed for rays and eight hours of data was processed for modes. The resultant travel time information is then available for inversion to sound speed maps.

RESEARCH ON THE SONAR HARDWARE SYSTEM ON AN AUTONOMOUS MOBILE ROBOT

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The autonomous mobile robot, Yamabico-11, recognizes distance from obstacles by a transmit and receive sonar pair. However, the current sonar amplification has not been enough to obtain reliable range information. This thesis describes methods to improve the sonar analog circuits on the autonomous mobile robot so that they obtain more robust range information.

One improvement was a change in the driving voltage of the transmit transducer from 5 volts to 12 volts which doubles the strength of sonar signal received by the pickup sensor. After changing the voltage source, it was found that there was spillover leakage directly from the transmitter to the receiver transducer. The amplifier sensitivity was decreased for the first one millisecond to reduce the spillover.

SHALLOW WATER REVERBERATION MEASUREMENT AND PREDICTION

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Low frequency active sonar performance in shallow water is often limited by reverberation. Reverberation modeling in shallow water has been difficult due to the complexity of the multipath acoustic propagation problem inherent in shallow environments. In August 1992, a shallow water, low-frequency reverberation measurement was made in the Barents Sea utilizing explosive "signal, underwater sound" (SUS) charges as sound sources and a 16-element vertical hydrophone array as the receiver. The objectives of this thesis were to analyze the reverberation data from this experiment, compare several theories which have been proposed to model reverberation, and determine the reverberant characteristics of the region. The three-dimensional Hamiltonian Acoustic Ray-tracing Program for the Ocean (HARPO) was used as the primary propagation modeling tool. The temporal signal processing consisted of a short-time Fourier transform spectral estimation method applied to data from a single hydrophone. Chapman's source spectrum model was used. Reverberation models based on Lambert's law and omnidirectional backscattering theory were compared. Lambert's law was found to be more applicable in the Barents Sea. A statistical analysis was performed on broadband and narrowband hydrophone data showing that reverberation in the Barents Sea possesses Gaussian properties.

A SCALABLE DECENTRALIZED GROUP MEMBERSHIP SERVICE FOR AN ASYNCHRONOUS ENVIRONMENT

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This thesis presents a globally scalable, decentralized group membership service to manage client process groups operating in a distributed, asynchronous environment. This group membership service is totally scalable, handling process groups spanning a single LAN to groups spanning the entire global Internet equally well. It provides for nested and overlapping groups, as well as multiple groups residing on a single LAN. It also provides various Quality of Service selections which permit individual groups to be configured for an optimal balance between high quality with strong consistency semantics for group membership, and weaker consistency semantics with reduced complexity and latency.

This thesis describes the complete design of the protocol used to implement the group membership service. It presents the design requirements and goals, and underlying assumptions about the network. The various Quality of Service selections provided by the group membership service are described in detail, as well as the interface between the process groups, the membership service, and the underlying network. The use of a hierarchical architecture to obtain the desired scalability, flexibility, and robustness is explained. A proof of correctness for the protocol is presented, and a partial implementation of the group membership service is described.

MODELING AND SIMULATION OF A FIBER DISTRIBUTED DATA INTERFACE LOCAL AREA NETWORK (FDDI LAN) USING OPNET^R FOR INTERFACING THROUGH THE COMMON DATA LINK (CDL)

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The Optimized Network Engineering Tool (OPNET^R) is a commercially available communications network simulation package. This thesis involves the modification of OPNET^{R}s Fiber Distributed Data Interface Local Area Network (FDDI LAN) model in order to enhance its usefulness as an aid in the development of recommendations for the characteristics and metrics to be eventually included in the Defense Service Project Office's (DSPO) Common Data Link (CDL) project. This work includes a step-by-step guide for FDDI simulation in OPNET^R, and a discussion of the changes made to the original model enhance its performance and data display characteristics. Simple tests are provided to verify the completed model's performance and usefulness as a working tool for further development.

DEVELOPMENT OF A FREQUENCY-DOMAIN ELECTROMAGNETIC SCATTERING MEASUREMENT SYSTEM

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This thesis describes the development of a system for measuring frequency-domain scattered fields in the Transient Electromagnetic Scattering Range at the Naval Postgraduate School. The new system employs a stepped-frequency CW waveform and utilizes an HP-8510B network analyzer as an RF front-end and a coherent receiver. A pair of AEL H1498 antennas was installed to cover a frequency range of 2 GHz to 18 GHz. An HP-82300C BASIC Language Processor was installed on a COMPAQ Deskpro-386 PC, and an HP-BASIC program was developed for remote control of the HP-8510B with data acquisition over the HPIB bus. A post-processing algorithm was created using MatLab for background subtraction, calibration, and deconvolution. A set of RCS measurements was made using various size spheres, and the post-processing outputs were compared to computed values. Good agreement between these measurements and computed data indicates excellent accuracy of the measurement system and valid operations of the post-processing algorithm.

HIGH RADAR RANGE RESOLUTION WITH THE STEP FREQUENCY WAVEFORM

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High range resolution can be obtained using a number of methods including ultrawideband radar, intrapulse pulse compression, and super-resolution techniques. This thesis investigates the achievement of high radar range resolution by means of the step frequency waveform. The key advantage of the step frequency approach compared to other methods is the wide total bandwidth resulting in high range resolution while still maintaining a narrow instantaneous bandwidth which eases A/D sampling requirements. The effects various waveform parameters on the high resolution range profile are determined for both noise and clutter limited environments. A novel technique is developed which enhances the resolution of moving targets in clutter and estimates the target velocity. This method consists of clutter cancellation followed by successive velocity compensations. Finally, design methods are developed to optimize system performance in a low PRF mode for both noise and clutter limited environments.

A TRIANGULATION METHOD FOR PASSIVE RANGING

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A method for passive ranging based on the principle of triangulation is considered. In the basic triangulation scheme, that is a single baseline model, the precision in the bearing readings can be related to the precision in the range estimation. For some target orientations the precision in the triangulated target range is completely lost. This phenomenon is known as "geometric dilution." effect. The performance of each of the two orthogonal baselines depends on target orientation. For specific target orientations the triangulation range measurements for the two baselines are equivalent. The dual baseline scheme would require "smart electronics" which would switch between baselines at crossover points in the range estimation precision. It is shown that the crossover points depend primarily on the ratio of the two baselines. A general expression for the maximum triangulation range consistent with limitations in minimum tolerance precision in range estimation is derived. The dependency between maximum range and target orientation are presented in polar form. Limitations in the dual baseline model due to the physical limitation created by the optical horizon are also considered.

IMPLEMENTATION AND EVALUATION OF AN ASYNCHRONOUS GROUP MEMBERSHIP PROTOCOL

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A group membership protocol provides the mechanisms to ensure the consistent group views among a group-oriented distributed processes. The protocol is required to dynamically re-configure the group views among the various members in the event of a change to the group due to a new member joining or a member departing. The departure may be voluntary or involuntary. The protocol must provide a scheme to detect the failure of any of the members and re-configure the group. Multiple changes to the group must be perceived at all members in the same order.

This thesis deals with a particular group membership protocol. The protocol structures the group as a logical ring. Changes to the group are accomplished using a two-phase scheme. The agreement phase consists of circulation of an agree token. Processing the token makes a pending change known to all members. The commit phase incorporates the changes in the correct order.

This thesis presents an implementation of this asynchronous group membership protocol. The main feature is that the decentralized nature of the protocol eliminates the need for a dedicated coordinator of changes. The processing requirements for the protocol are likewise distributed. The processing time required to implement a change to the group is shown to have a linear relationship to the group size.

DESIGN AND TESTING OF AN OPTICAL LINK CAPABLE OF 14-CHANNEL TRANSMISSION

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This thesis presents the design, implementation and evaluation of a communication system, capable of serializing 14-channel digital parallel data, transmission and reception of the serial data over a high speed fiber link at 39 Mbps and converting the serial data back to 14-channel parallel form. A time division multiplexing technique was used to transmit the data. The high-speed Emitter-Coupled logic devices were employed to construct the design.

A TECHNIQUE FOR MULTIPLEXING 3X3-COUPLER TERMINATED INTERFEROMETRIC FIBER-OPTIC SENSORS

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This thesis investigates the multiplexing of Mach-Zehnder type 3x3 terminated fiber-optic sensors demodulated by either 'quadrature' or 'symmetric' methods using intensity modulation of the source. 3x3- couplers produce signals that permit unmodulated passive demodulation of interferometric signals. The theory is described and the results of a 2x1 element array optical demonstration are presented. Possible architectures using this demultiplexing technique are presented for several applications with different return line requirements. The technique was successfully demonstrated and warrants further investigation to increase the number of sensors and reduce the number of return lines for specific applications. The multiplexing technique presents the opportunity for possible cost savings over other phase generated carrier techniques, which require wavelength modulation of the source, and significant optical path differences in the interferometers, and are therefore constrained to presently very expensive sources. The technique presented uses compatible low coherent laser sources such as Compact Disc quality (830 nm) devices.

A CMOS VLSI IC FOR REAL-TIME OPTO-ELECTRONIC TWO-DIMENSIONAL HISTOGRAM GENERATION

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Histogram generation, a standard image processing operation, is a record of the intensity distribution in the image. Histogram generation has straight forward implementations on digital computers using high level languages. A prototype of an optical-electronic histogram generator has been designed and tested for 1-D objects using wirewrapped MSI TTL components. The system has shown to be fairly modular in design. The aspects of the extension to two dimensions and the VLSI implementation of this design are discussed.

In this paper, we report a VLSI design to be used in a two-dimensional real-time histogram generation scheme. The overall system design is such that the electronic signal obtained from the optically scanned two-dimensional semi-opaque image is processed and displayed within a period of one cycle of the scanning process.

Specifically, in the VLSI implementation of the two-dimensional histogram generator, modifications were made to the original design. For the two-dimensional application, the output controller was analyzed as a finite state machine. The process used to describe the required timing signals and translate them to a VLSI finite state machine using Computer Aided Design Tools is discussed. In addition, the circuitry for sampling, binning, and display have been combined with the timing circuitry on one IC. In the original design, the pulse width of the electronically sampled photodetector is limited with an analog one-shot. The high sampling rates associated with the extension to two dimensions requires significant reduction in the original 1-D prototype's sample pulse width of approximately 75 ns. The alternate design using VLSI logic gates will provide one-shot pulse widths of approximately 3 ns.

DESIGN OF ELECTRONIC EXPERIMENTS USING COMPUTER GENERATED VIRTUAL INSTRUMENTS

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Master of Science in Electrical Engineering-March 1994
Advisor: Sherif Michael-Department of Electrical and Computer Engineering

The recent availability of low-cost computer controlled data acquisition systems have made it conceptually possible to replace much of the data recording and data analysis work associated with the classical electronics laboratory experiments required in a typical Electrical Engineering program. This thesis reports the results of a study focused on putting those concepts into practice. It is the first application of student laboratory Virtual Instruments at the school.

Specifically, this thesis reports on the practicality of using a standard personal computer equipped with National Instruments LabVIEW for Windows and a data acquisition board to replace the typical manual instrumentation and data extraction required for seven Naval Postgraduate School ECE 2200 laboratory experiments. Appendices include the front panel display with associated block diagram code and the revised course laboratory experiments.

PERFORMANCE OF A FAST FREQUENCY-HOPPED NONCOHERENT MFSK RECEIVER OVER RICIAN FADING CHANNELS WITH EITHER PARTIAL-BAND INTERFERENCE OR MULTI-TONE INTERFERENCE

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Master of Science in Electrical Engineering-September 1994
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An error probability analysis is performed for a conventional noncoherent M-ary orthogonal frequency-shift keying (MFSK) receiver employing fast frequency hopped (FFH) spread spectrum waveforms transmitted over a frequency-nonselective, slowly fading Ricean channel with partial-band noise interference. Each diversity reception is assumed to fade independently. The partial-band interference is modeled as a Gaussian process. the effects of wideband thermal noise are also included. The energy per hop is held constant; thus, as diversity increases, energy per symbol increases. Previous analyses considered only constant energy per symbol systems, however, practical military systems are likely to employ fixed hop rates. There is some performance enhancement to be obtained from implementing diversity in a conventional FFH/MFSK system with fixed hop rates, but partial band interference still results in significant degradation. Additionally, the performance of this FFH receiver is investigated over the same channel in the presence of partial-band tone jamming without diversity for the case of binary frequency-shift keying (BFSK) when both the signal and the jammer can fade independently. Performance when only a single jamming tone per hop slot is allowed is compared to that obtained when two jamming tones per hop slot are possible. When the jamming signal experiences Rayleigh fading there is very little degradation of the jammer's effectiveness as compared to when the jamming signal is not affected by fading.

VLSI IMPLEMENTATION OF STRAY INSENSITIVE SWITCHED CAPACITOR COMPOSITE OPERATIONAL AMPLIFIERS

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In this research, analog active circuits are implemented in VLSI technology by combining the properties of switched capacitors and composite amplifiers. This combined design improves upon the single operational amplifier's finite dc gain, limited bandwidth, lower slew rate, as well as enhancing the overall network passive and active sensitivities. The switched capacitor is implemented using both the toggle switched capacitor and the modified open floating resistor techniques. The composite operational amplifier is implemented using the C2OA-1 and C2OA-2 designs from the CNOA-i possibilities. These four designs are produced on a single microchip that includes the two phase non-overlapping clock circuit and the switches. The microchip is tested in a finite gain circuit and the results are used to evaluate the performance of the design. Short comings in the circuit performance are identified and the analysis is used to improve network simulations as well as provide guidance for design improvements. The design improvements are incorporated in a second generation microchip that is fabricated in a low analog process.

SACS: A CACHE SIMULATOR INCORPORATING TIMING ANALYSIS WITH BUFFER AND MEMORY MANAGEMENT

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SACS is a cache simulator that provides the user with a wide range of timing information, in addition to providing typical information such as hit and miss rates. The SACS model includes read and write buffers, main memory, and cache memory. In addition, SACS supports a number of buffer and data forwarding policies, as well as the traditional block replacement, write, and write miss policies. SACS also includes a self-testing mode which can be used to debug the program after source-code modification.

ELIMINATION OF ELECTROMAGNETIC INTERFERENCE TO RECEIVERS AND SENSITIVE EQUIPMENT GENERATED BY SWITCHING SYSTEMS

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Recently installed equipment in naval receiving sites such as digital telephone switching systems, uninterruptible power supplies, laser printers etc., induce Electromagnetic Interface (EMI) into receiver systems, thus limiting the performance of the receiving site. EMI is injected into receiver systems by conducted, inductive and capacitive paths associated with poor compartment shielding , grounds, or cable shielding. In this thesis, the MITEL SX-20 automatic digital telephone switching system is studied as an EMI source. Temporal and spectral properties of EMI generated by the MITEL SX-20 system are examined over a frequency range of 0 to 100 MHz. The effectiveness of a Barrier, Filter and Ground architecture in containing/eliminating the generated EMI is tested under various operating conditions. Possible solutions are proposed for similar EMI sources.

PARALLEL PROCESSING OF NAVY SPECIFIC APPLICATIONS USING A WORKSTATION CLUSTER

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Master of Science in Electrical Engineering-December 1993
Advisor: Shridhar Shukla-Department of Electrical and Computer Engineering
Co-Advisor: Beny Neta-Department of Mathematics

In this thesis the benefits of parallel computing using a workstation cluster are explored for two typical Naval applications. The applications are examples of one off-line and one on-line program. The off-line program is a Navy program currently in use by the Naval Space Command in its satellite prediction model. The on-line program is a large grain data flow problem with critical throughput requirements and represents a hypothetical combat weapons system. Data and function decomposition techniques are used in both applications. Speedup and throughput are the performance metrics studies.

The software employed was the Parallel Virtual Machine (PVM) by the Oak Ridge National Laboratory. PVM enables a network of heterogeneous workstations to appear as a parallel multicomputer to the user programs. PVMS runs over the workstation operating system and provides the user with a set of library calls for message passing and process creation.

A SIMPLE ANALYTICAL MODEL FOR DENSE WDM/OOK SYSTEMS

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B.S., Chinese Naval Academy, November 1983
Master of Science in Electrical Engineering-June 1994
Advisor: Tri T. Ha-Department of Electrical and Computer Engineering

We derive the closed form expression for the bit error probability of dense WDM systems employing an external OOK modulator. Our model is based upon a close approximation of the optical Fabry-Perot filter in the receiver as a single-pole RC filter for signals that are bandlimited to a frequency band approximately equal to one sixtieth of the Fabry-Perot filter's free spectral range. Our model can handle bit rates up to 2.5 Gb/s for a free spectral range of 3800 GHZ and up to 5 Gb/s when the power penalty is 1dB or less.

SELECTION AND INTEGRATION OF A GLOBAL POSITIONING SYSTEM RECEIVER WITH A CPU

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Advisor: Mike Shields-Department of Electrical and Computer Engineering

The Global Positioning System (GPS) is revolutionizing the science of navigation. Never before has there been a system that could provide real time, work wide, continuous coverage with the such precision. Yet, the accuracy achievable with GPS alone is not vehicle. However, when integrated with an Inertial Navigation System and other non-intertial sensors using a Kalman Filter, GPS supplies the critical positioning information to permit such an achievement.

This thesis presents the selection and integration a GPS receiver using Differential GPS (DGPS) in support of a UAV autonomous flight project. Contemporary electronic navigation systems are surveyed, GPS operation is reviewed, and a Motorola PVT-6 GPS receiver selected. Using the Motorola Proprietary Binary Format protocol, several software drivers were written in C to interface the information to an Intel 80486DX CPU using the RS-232 serial communication standard. Finally, an examination is made to determine the maximum reacquisition time, the DGPS accuracies achievable and the effects of pseudorange correction latency on DGPS accuracy.

ENHANCEMENT OF EMAG: A 2-D ELECTROSTATIC AND MAGNETOSTATIC SOLVER FOR MATLAB

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Master of Science in Electrical Engineering-September 1994
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This thesis presents the theory and development involved in the enhancement of EMAG, a 2-D electrostatic and magnetostatic solver, to allow it to solve problems involving rotational symmetry. EMAG 2.0 solves rotationally symmetric problems using discrete forms of the Poisson equations for electrostatics and magnetostatics in cylindrical coordinates. EMAG 2.0 is written entirely in MATLAB script format. It allows users to define electrostatic or magnetostatic problems on a 2-d grid and solve the problem for the potentials at uniformly spaced nodes on the grid. Graphical displays allow the users to visualize contour or mesh plots of potential, vector plots of electric or magnetic fields and to calculate the charge or current enclosed in a user defined region of the grid. The EMAG 2.0 computational grid has a simulated open boundary which is generated by the Transparent Grid Termination (TGT) technique. This boundary is unique to the type of system being solved. This thesis presents and compares two different methods for generating this boundary, one involving a probabilistic model of the system and the other using a direct matrix solution approach. Optimization of the Transparent Grid Termination technique is also explored.

MULTIPLE-VALUED PROGRAMMABLE LOGIC ARRAY MINIMIZATION BY SOLUTION SPACE SEARCH

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A minimal realization of a multiple-valued programmable logic array can only be achieved by exhaustive search. However, an exhaustive search is unrealistic even with the high speed CPU's in use today. Heuristic algorithms have been developed that provide near-minimal solutions, using significantly less CPU time. This investigates a new type of heuristic that uses implicant operations (combine, reshape, and cut) to move through the solution space. The choice of move is dynamically controlled by feedback from a queue of previous moves, called a TABU queue. This new heuristic performs better than existing heuristics, in certain situations, but requires more CPU time than direct cover methods.

In addition, this heuristic provides a unique capability to fix the move acceptance probabilities associated with the basic implicant operations. Fixing move acceptance probabilities allows a study of the solution space of multiple-valued logic functions under controlled conditions. For example, the results of a preliminary study into the solution space of a four-valued, three variable special function (SF) are presented. This suggests that the search space is not homogenous; rather it suggests that the space is segmented with restrictive access between segments. The results of such studies will be a basis for improving the performance of current and future minimization heuristics.

EMITTER LOCATION VIA KALMAN FILTERING OF SIGNAL TIME DIFFERENCE OF ARRIVAL

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Master of Science in Electrical Engineering-September 1994
Electrical Engineer-September 1994
Advisor: H. Titus-Department of Electrical and Computer Engineering

A relatively simple time domain method is developed to calculate the time of arrival for radar signals. The error present in the estimate of time of arrival for a single pulse and a burst of pulses are developed and the effects of SNR, PRF, pulsewidth, and sampling frequency are examined. Time of arrival is used with multiple sensors and the Kalman filter to estimate the location of the emitter. Algorithms estimate the location of an emitter given the Time Difference of Arrival (TDOA) of a single pulse as well as the TDOA of bursts of pulses received as the emitter scans past the receivers. The algorithms were tested on simulated data.

RADIATION TOLERANT, HIGH SPEED, LOW POWER, GALLIUM ARSENIDE LOGIC

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Advisor: Douglas J. Fouts-Department of Electrical and Computer Engineering

GaAs circuits are largely immune to slowly accumulated radiation doses and therefore do not need the shielding required by CMOS devices. This attribute renders GaAs circuits particularly attractive for space craft and military applications.

However, it has been shown that GaAs circuits with short gate lengths are excessively susceptible to single event upsets (SEU) due to enhanced charge collection at the edges of the gate called "edge effect".

This thesis studies the SEU problem in two parts. Extensive computer modeling and simulation of a charged particle passing through various transistors of a low power, two-phase dynamic MESFET logic (TDFL) test chip is conducted using HSPICE in the first part. In the second part, new GaAs logic topologies are developed, simulated, and layed out on an integrated circuit which require less power than directly coupled MESFET logic (DCFL) and should be less susceptible to single event upsets than TDFL circuits.

LOW ALTITUDE NEAR-THE HORIZON PROPAGATION: A COMPARISON BETWEEN RPO AND M-LAYER

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Master of Science in Electrical Engineering-December 1993
Advisor: Hung-Mou Lee-Department of Electrical and Computer Engineering

Predictions of propagation loss made by the computer programs Radio Physical Optics (RPO) Computer Software Configuration Item (CSCI) and M-layer are compared. The results of the high frequency parabolic equation approximation, as formulated in RPO, agree almost always with those derived from the low frequency modal computation as formulated in M-layer. But at low altitudes in the neighborhood of the radar horizon, deviations between RPO and M-layer become significant for some cases. RPO appears not to be able to properly account for the effects of a high altitude surface-based duct at a short range. Since the discrepancies fall in regions of importance to naval operations, a definitive resolution is an urgent task to be undertaken in the immediate future.

OPTIMAL ADAPTIVE ESTIMATION ALGORITHM FOR HARMONIC CURRENT REDUCTION USING POWER LIMITED ACTIVE LINE CONDITIONERS

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Advisor: Robert W. Ashton-Department of Electrical and Computer Engineering

The ability to measure and compensate for power line harmonics has become a growing area of interest of today's commonly used electronic equipment. Since the number and relative magnitudes of the harmonics on the power line are a function of the load, estimation of an equivalent load can be accomplished. Because of variation in the load, the need for an adaptive algorithm is imperative. Thus far, few algorithms for determining harmonic contents have not dealt with the problem associated with the limited power of the line conditioner.

This thesis deals with a previously known harmonic compensating algorithm and introduces a new algorithm which both compensates for harmonic noise and estimates the load as a transformation matrix depending on the associated transfer function of the active line conditioner in use.

MASTER OF SCIENCE
IN
ENGINEERING ACOUSTICS

TECHNIQUES FOR THE INVESTIGATION OF DETERMINATION OF THE COMPLEX ELASTIC MODULI OF MATERIALS USING A "FREE-FREE" BAR TECHNIQUE

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Master of Science in Engineering Acoustics-March 1994
Advisor: David A. Brown-Department of Physics

The objective of this research is to investigate the dynamic elastic properties of materials and their temperature and frequency dependence using an acoustic resonance based method. In this technique, the torsional, flexural, and/or longitudinal vibrational modes of a "free-free" bar are selectively excited and tracked as a function of temperature. The resonance frequency of the torsional mode is used to obtain the dynamic shear modulus. The dynamic Young's modulus is obtained from either the resonance frequency of the flexural or longitudinal mode of the bar. The quality factor, Q, of each mode is measured to obtain the dampling properties of the material. A two channel phase-locked loop (PLL) is used to track the resonance frequency as a function of changing temperature for the particular resonance mode selected. Using this technique, the storage modulus and loss tangent may be obtained in a continuous fashion. Materials testing in this thesis include: Polyurethane PR-1592, a common sonar encapsulant, Polymethyl Methacrylate (PMMA) or plexiglass, and Polycarbonate. This research encompasses the theory, accuracy, limitations, and applications of this measurements technique.

DESIGN OF A DIGITAL INTERFEROMETRIC DEMODULATOR

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This thesis investigates the design of a digital fiber-optic interferometric demodulator based upon a passive symmetric combination of signals produced by an interferometer terminated with a 3x3 optical coupler. The demodulator was implemented using a digital signal processing (DSP) board based upon a TMS320C31 DSP processor. The demodulator was tested using signals produced by a set of interferometric simulators which used an analog AD639 trigonometric chip. A goal of this thesis was to demonstrate an improved noise floor at low frequencies as compared with a similar analog implementation.

ELECTRODYNAMIC BEHAVIOR OF PMG-DELTA

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Master of Science in Engineering Acoustics-June 1994
Advisor: Richard C. Olsen-Department of Physics

The PMG-Delta experiment was launched on 26 June 1993 to test basic tether electrodynamic principles. The 500 m conducting tether deployed from the second stage of a Delta-rocket, and provided ~3 orbits of useful information. The tether was equipped at both ends with xenon hollow cathodes. With both cathodes operating, currents up to 0.3 A could be driven in either direction. Plasma impedances outside the tether were as low as a few hundred ohms at peak current during daytime/perigee (200 km). Large impedances (10,000 ~ 100,000 ohms) occurred at night/apogee (900km), or when one cathode cycled off.

TECHNIQUES FOR THE INVESTIGATION OF WAVE TURBULENCE IN WATER WAVE DATA

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B. Math, University of Waterloo, May 1990
Master of Science in Engineering Acoustics-September 1994
Advisor: Robert M. Keolian-Department of Physics

Computer based tools were developed to search water wave data for a collective mode predicted by wave turbulence theory. A low frequency wave, the "swell," can drive the collective mode by compressing and expanding the field of high frequency waves, the "chop." Through non-linear interactions, the chop responds with its own collective stiffness and inertia. This inertia should cause modulations of the chop amplitude to lag in phase behind the forcing from the swell. Two methods are presented for investigating the phase relationships between the chop amplitude and the swell. Method one employs the Fast Fourier Transform to examine directly the power levels at various frequencies. Method two employs digital signal processing to separate the swell and chop frequencies and the Hilbert Transform to compute the instantaneous phase of the swell and instantaneous amplitude of the chop. Various plotting techniques permit the examination of the relationships betwen the amplitude of the chop and the phase of the swell. The second method provided evidence of the existence of the collective mode when applied to data collected in a wave tank experiment described herein.

COMPUTER IMPLEMENTATION OF ARNOTT'S FORMULATION OF THERMOACOUSTICS USING MATLAB

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Master of Science in Engineering Acoustics-December 1993
Advisor: Anthony A. Atchley-Department of Physics

This thesis describes a Matlab computer program that implements Arnott's formulation of thermoacoustics [W.P. Arnott, et. Al., "General formulation of thermoacoustics for stacks having arbitrarily shaped pore cross sections," Journal of the Acoustical Society of America, 90(6), 3228-3237 (1991)]. The program calculates the resonance frequency and the quality factor of a thermoacoustic prime mover below onset of self-oscillation. The results of this analysis are compared to measured values for both a closed end and an open end prime mover and to predictions of standing wave analysis of prime movers [A.A. Atchley, "Standing wave analysis of a thermoacoustic prime mover below onset of self-oscillation," Journal of the Acoustical Society of America, 92(5), 2907-2914 (1992)].

DIRECT DETECTION AND COHERENT OPTICAL SYSTEMS EMPLOYING ERROR-CORRECTION CODING

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Master of Science in Engineering Acoustics-June 1994
Advisor: Tri T. Ha-Department of Electrical and Computer Engineering

We evaluate the bit error probability of coded lightwave systems employing direct detection with OOK modulation, and coherent optical systems with FSK modulation and noncoherent detection. Block codes, convolutional codes, and concatenated codes are investigated. For direct detection systems, both hard and soft decoding are considered. Only hard decoding is employed in coherent optical systems.

CALCULATION OF THE TRANSITION MATRIX FOR THE SCATTERING OF ACOUSTIC WAVES FROM A THIN ELASTIC SPHERICAL SHELL USING THE ATILA FINITE ELEMENT CODE

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M.S., University of Rio de Janeiro, 1992
Master of Science in Engineering Acoustics-March 1994
Advisor: Clyde L. Scandrett-Department of Mathematics

The transition matrix, relating the scattered and incident acoustic waves for a thin elastic spherical shell in a free- field environment, has been evaluated using the ATILA finite-element code. A three-dimensional finite-element model of a 0.5-m outer radius, 1-cm thick spherical steel shell surrounded by water was developed. The ATILA code was used to calculate the scattered pressure over the surface of the shell for incident waves represented as products of radial Hankel functions and spherical harmonics. The chosen driving frequency was 474 Hz, corresponding to a value of ka=1, where k is the wavenumber of sound in water and a is the radius of the shell. The ATILA results were compared with the results of analytical thin shell theory, and were found to agree for a model which divided the spherical shell surface into 72 approximately equal area triangular regions. Also computed for each component was the modal acoustical impedance of the shell. These results agreed within two percent for the zeroth order component and thirteen percent for the first order components.

SIGNAL PROCESSING FOR THE 1992 BARENTS SEA TOMOGRAPHY EXPERIMENT

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Master of Science in Engineering Acoustics-December 1993
Advisors: James H. Miller-Department of Electrical and Computer Engineering and Ching-Sang Chiu-Department of Oceanography

In August 1992, an acoustic tomography experiment was conducted in the Barents Sea. The objective of this thesis is the development of space-time signal processing algorithms to extract the arrival times of rays and modes for that experiment. The temporal signal processing involves pulse compression and the phase-encoded signal. Spatial signal processing consists of plane wave and modal beamforming on data from a 16 element vertical line array. After signal processing an arrival detection, identification, and tracking algorithm is used to obtain travel time and travel time error estimates. After development and testing of these algorithms, 13 hours of acoustic data was processed for rays and eight hours of data was processed for modes. The resultant travel time information is then available for inversion to sound speed maps.

SHALLOW WATER REVERBERATION MEASUREMENT AND PREDICTION

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Low frequency active sonar performance in shallow water is often limited by reverberation. Reverberation modeling in shallow water has been difficult due to the complexity of the multipath acoustic propagation problem inherent in shallow environments. In August 1992, a shallow water, low-frequency reverberation measurement was made in the Barents Sea utilizing explosive "signal, underwater sound" (SUS) charges as sound sources and a 16-element vertical hydrophone array as the receiver. The objectives of this thesis were to analyze the reverberation data from this experiment, compare several theories which have been proposed to model reverberation, and determine the reverberant characteristics of the region. The three-dimensional Hamiltonian Acoustic Ray-tracing Program for the Ocean (HARPO) was used as the primary propagation modeling tool. The temporal signal processing consisted of a short-time Fourier transform spectral estimation method applied to data from a single hydrophone. Chapman's source spectrum model was used. Reverberation models based on Lambert's law and omnidirectional backscattering theory were compared.

Lambert's law was found to be more applicable in the Barents Sea. A statistical analysis was performed on broadband and narrowband hydrophone data showing that reverberation in the Barents Sea possesses Gaussian properties.

A TECHNIQUE FOR MULTIPLEXING 3X3-COUPLER TERMINATED INTERFEROMETRIC FIBER-OPTIC SENSORS

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Advisors: David A. Brown-Department of Physics and
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This thesis investigates the multiplexing of Mach-Zehnder type 3x3 terminated fiber-optic sensors demodulated by either 'quadrature' or 'symmetric' methods using intensity modulation of the source. 3x3-couplers produce signals that permit unmodulated passive demodulation of interferometric signals. The theory is described and the results of a 2x1 element array optical demonstration are presented. Possible architectures using this demultiplexing technique are presented for several applications with different return line requirements. The technique was successfully demonstrated and warrants further investigation to increase the number of sensors and reduce the number of return lines for specific applications. The multiplexing technique presents the opportunity for possible cost savings over other phase generated carrier techniques, which require wavelength modulation of the source, and significant optical path differences in the interferometers, and are therefore constrained to presently very expensive sources. The technique presented uses compatible low coherent laser sources such as Compact Disc quality (830 nm) devices.

MASTER OF SCIENCE
IN
ENGINEERING SCIENCE

TIME-OPTIMAL CONTROL OF A THIRD ORDER REGULATOR

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Master of Science in Engineering Science (EE)-June 1994
Advisor: Hal Titus-Department of Electrical and Computer Engineering

The time-optimal control law as a function of the states for second and third-order linear regulators with real eigenvalues was derived. Notions of switching curve for the second-order system and switching surface for the third-order system was introduced. A set of states was found which divided the state space into two distinct regions, in one of which the time-optimal control was +1 and in the other of which the time-optimal control was -1.

BACK-PROPAGATION NEURAL NETWORKS IN ADAPTIVE CONTROL OF UNKNOWN NONLINEAR SYSTEMS

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The objective of this thesis research is to develop a Back-Propagation Neural Network (BNN) to control certain classes of unknown nonlinear systems and explore the network's capabilities. The structure of the Direct Model Reference Adaptive Controller (DMRAC) for Linear Time Invariant (LTI) systems with unknown parameters is first analyzed and then is extended to nonlinear systems by using BNN. Nonminimum phase systems, both linear and nonlinear, have also been considered. The analysis of the experiments shows that the BNN DMRAC gives satisfactory results for the representative nonlinear systems considered, while the conventional least-squares estimator DMRAC fails. Based on the analysis and experimental findings, some general conditions are shown to be required to ensure that this technique is satisfactory. These conditions are presented and discussed. It has been found that further research needs to be done for the nonminimum phase case in order to guarantee stability and tracking. Also, to establish this as a more general and significant control technique, further research is required to develop more specific rules and guidelines for the BNN design and training.

LASER-DOPPLER VELOCIMETER MEASUREMENTS IN A CASCADE OF CONTROLLED DIFFUSION COMPRESSOR BLADES AT STALL

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Master of Science in Engineering Science-June 1994
Advisor: Garth V. Hobson-Department of Aeronautics and Astronautics

An incipient compressor blade stall has been generated and examined in the Low Speed Cascade Wind Tunnel at the Turbopropulsion Laboratory. The test blades were a controlled-diffusion design with solidity 1.67, and stalling occurred at 10 degrees of incidence above the design inlet air angle. Tufting and laser-sheet flow-visualization techniques showed that the stalling process was unsteady, and occurred over the whole cascade of 20 blades. Detailed laser-doppler velocimeter measurements over the suction side of the blades showed regions of continuous and intermittent reversed flow. The measurements of the continuous reversed flow region at the leading edge were the first data to be obtained of flow within the leading edge separation bubble. The intermittent reversed flow region measurements quantified what was observed in the flow visualization studies. Blade surface pressure measurements showed a decrease in normal force on the blade as would be expected at stall.

COMPUTER GRAPHICS TOOL FOR THE VISUALIZATION OF SPACECRAFT DYNAMICS

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M.S., Golden Gate University, 1990
Master of Science in Engineering Science-December 1993
Master of Science in Computer Science-December 1993
Advisor: I. Michael Ross-Department of Aeronautics and Astronautics

This thesis consists of teaching tools designed to allow spacecraft engineering students to visualize the various phenomena associated with spacecraft dynamics. It does so via the use of state of the art three dimensional computer graphics on Silicon Graphics computers. The thesis discusses the principles in dynamics that were implemented and the key design considerations. A central goal was to develop applications that were user friendly. A library of functions were developed called Dynamics Programming Library or DPL. DPL shields the users from the details of computer graphics, thus allowing them to concentrate on the dynamics of the problem. DPL was used to write three main applications: Euler, Frame, and Gyro. Euler demonstrates the representation of orientation using Euler angles and quaternion rotation. Gyro demonstrates the effects of torques applied to varying rigid body geometries and inertias. Frame allows students to view the motion of an object from different frames of reference. A group of 21 spacecraft engineering students participated in a lab exercise using these programs. Within 20 minutes, the students could run the simulations thus validating their user friendliness.

ADAPTIVE CONTROL FOR A SPACECRAFT ROBOTIC MANIPULATOR

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Master of Science in Electrical Engineering-December 1993
Advisors: Brij Agrawal-Department of Aeronautics and Astronautic and
Roberto Cristi-Department of Electrical and Computer Engineering

This research involves the development of an adaptive control law for a space based two-link robotic manipulator. Non-adaptive controllers are first obtained utilizing feedback linearization techniques. A direct adaptive controller is then developed through the linear parameterization of the system dynamics, and the implementation of a Kalman Filter based adaption law. The controllers are then simulated and compared for various levels of system parameter uncertainty. The adaptive controller is found to be superior to the non-adaptive controllers for high levels of system parameter uncertainty. The non-adaptive controller is found to compare favorably to the adaptive controller in some areas for low values of system parameter uncertainty. The non-adaptive controller is implemented experimentally, consistent with hardware constraints. Experimental results verify the need for adaptive control when system dynamics are present which have not been modelled.

SONAR BASED NAVIGATION OF AN AUTONOMOUS UNDERWATER VEHICLE

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A navigation algorithm to navigate an AUV within a charted environment is presented. The algorithm uses sonar range measurements and incorporates them with a potential function which defines the map of the operation area. Extended Kalman filtering is used in the algorithm. Least squares techniques are used in the estimation of system parameters. The algorithm is tested by both computer generated data and actual data collected from the vehicle NPS AUVII during tests in a water tank. Fixed interval smoothing is applied in order to smooth the estimates produced by Kalman filter. The effects of currents in the operation area are sought. An approach based on backpropagation neural networks for the navigation algorithm is also presented. Throughout the simulation studies the algorithm yields a robust and reliable solution to the navigation problem of the AUV's.

THEORETICAL BASIS FOR STATE VECTOR COMPARISON, RELATIVE POSITION DISPLAY, AND RELATIVE POSITION/RENDEZVOUS PREDICTION

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This thesis outlines the theoretical underpinnings used for the software designed to meet Detailed Technical Objectives 700-6 and 700-7 for the Space Shuttle Discovery mission STS-51. The primary goal was to compare state vector information produced by an on board GPS receiver and Discovery's computers, and provide real time display of the results. Because state vector information for the ORFEUS/SPAS payload was also available, relative position and rendezvous information between Discovery and ORFEUS/SPAS was made possible. Analysis of the various state vectors was used to produce a graphical display, in an operationally meaningful format, to the flight crew of Discovery.

SONAR LOCALIZATION OF AN AUTONOMOUS UNDERWATER VEHICLE

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Two different algorithms to navigate an AUV within a charted environment are presented. They use sonar returns and a local map together with the dynamic model to estimate the vehicle's position and acceleration at all times. Kalman filtering techniques are used to compute the estimates. The main difficulty is the presence of uncharted obstacles, which are identified by the potential function algorithm. Results from the application of the potential function algorithm in a pool using Tritech ST725 high resolution sonar show the feasibility and robustness of the potential function approach to the navigation problem.

DEVELOPMENT OF A CASCADE SIMULATION OF FAN-PASSAGE FLOW

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A small-scale blowdown wind tunnel apparatus was developed to investigate techniques to alleviate the negative effects of shock-boundary layer interaction in the blading of aircraft engine fans. Using shadowgraph and surface injection techniques, probe surveys and static pressure measurements, it was shown that acceptable periodicity and repeatability could be obtained in a two-passage cascade model at M=1.4 if air supply pressure, back pressure and porous-wall bleed pressures were properly controlled. It was also shown that local separation due to shock boundary layer interaction was present at the design flow incidence of 1.15 degrees, but not at 0.85 degrees. Complete data are reported for the design condition to serve as a baseline for separation alleviation experiments. Necessary hardware and software developments are also documented.

ANALYSIS OF MULTIGRID TECHNIQUES FOR SYSTEM MODELING WITH TOEPLITZ APPROXIMATION

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An empirical analysis on the applicability of multigrid techniques to system modeling using system identification techniques is presented. Multigrid with the Toeplitz approximation algorithm is used to model an infinite impulse response (IIR) system with a finite impulse response (FIR) model. Matrix analysis experiments are conducted on the Toeplitz iteration matrix. A comparison of alternative multigrid operators for solving the system modeling problem is presented. The extension of multigrid techniques to system modeling of odd order filters is explored. Computer simulations are developed for analyzing the effectiveness of multigrid techniques in system modeling.

HOTWIRE MEASUREMENTS OF THE TURBULENT FLOW INTO A CASCADE OF CONTROLLED-DIFFUSION BLADES

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Turbulence measurements near the leading edge of a compressor stator blade were made in s aubsonic cascade wind tunnel with a Hotwire system. Using a single hotfilm probe, velocity and turbulence distortion data were obtained about the leading edge of the Controlled-Diffusion (CD) blades in order to verify Laser Doppler Velocimetry (LDV) data taken in earlier studies. Measurements were conducted at a Mach number of .25, a Reynolds number of 711000 and in inlet flow angle of 48 degrees. Turbulence profiles in the pitchwise direction were found to be in good agreement with previous LDV measurements. These data indicate a localized increase in turbulence around the leading edge due to the interaction of the free shear layer on the inlet turbulence. This free shear layer is situated around the leading edge of the blades and extends over the separation bubble, which forms on the suction side of the blades' leading edge.

MASTER OF SCIENCE
IN
INFORMATION SYSTEMS
MANAGEMENT

DOWNSIZING INFORMATION SYSTEMS: FRAMING THE ISSUES FOR THE OFFICE OF NAVAL INTELLIGENCE (ONI)

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Downsizing information systems from large and centralized mainframe computing architectures to smaller and distributed desktop systems is one of the most difficult and critical strategic decisions facing both corporate and government organizations. Vendor advertisements and media hype often boast of hugh cost savings and greater flexibility while retaining mainframe-strength performance. Cryptic terminology, biased vendor assistance, and rapidly changing technology complicate already difficult decisions. This thesis provides an executive summary for middle and top managers requiring a survey of the major downsizing issues. It provides an overview of architectural trends that are helping to fuel the downsizing process to include an emphasis on the client/server paradigm, the evolving roles of the mainframe and desktop computers, and innovative architectural software tools. An analysis of management and technical risks according to organizational, performance, and cost factors also focuses on such critical considerations as business process reengineering, open systems, flexibility, throughput, security, conversion costs, and life-cycle costs of downsized systems. Finally, this thesis "frames" the issues for the Office of Naval Intelligence and DoD by highlighting and outlining some general guidelines that may be used to intelligently plan strategy and make key organizational decisions.

X.400-BASED ENTERPRISE MESSAGING SYSTEM: INDUSTRY AND DEPARTMENT OF DEFENSE IMPLEMENTATION ISSUES

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In an unprecedented globally competitive market, industry demands an electronic mail or messaging system that will transport all forms of data. The Consultative Committee for International Telegraphy and Telephony (CCITT) X.400 family of standards is a messaging transport standard that facilitates international message exchange. Combined with an appropriate network architecture, the series provides a complete package for transport of electronic objects such as digitized voice, documents, forms, graphics, images, spread sheets and text. The purpose of this thesis is to provide DoD technicians and managers, who will be utilizing X.400-based E-Mail within the Defense Message System (DMS), with a thorough discussion of the X.400 standards. Highlighted by industry examples, possible, conceptual solutions for incorporating the standards into existing electronic messaging environments are provided.

TOWARDS BETTER QUALITY AND RELIABILITY IN THE SOFTWARE REUSE LIBRARY ENVIRONMENT

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In today's DoD software environment, where systems of enormous size, complexity and cost are the norm, economic conditions are driving DoD system developers to seek ways to increase productivity while decreasing product defects. To achieve its goals, DoD has taken the approach of integrating reuse into the software development process. In 1992, DISA established its Software Reuse Program to serve as a prototype for the DoD-wide reuse initiative. This thesis will look at DISA's effort to support DoD's reuse vision. Specifically, it will discuss DISA's software reuse library management and will introduce a methodology for the collection and analysis of metrics relating to software performance in order to improve library software quality. This thesis concludes that metrics can play a key role in any organization's software quality program. While metrics alone are not a solution to the reuse quality problem, they are a tool to be used prudently by the software quality manager to manage and improve the quality of organizational software.

MASTER OF SCIENCE
IN
INFORMATION TECHNOLOGY
MANAGEMENT

A SYSTEM DYNAMICS BASED STUDY OF SOFTWARE REUSE AND ITS DETERMINANTS

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Software cost for DoD is a critical issue. Software reuse promises significant savings by using previously developed components thus increasing productivity. Quality is improved because these components are well designed, well documented, and well tested. This thesis studies the determinants of software reuse using a system dynamics computer model, the Dynamica Reuse Model, which simulates the activities of a software development organization engaged in organization-wide, systematic software reuse. Results indicate that setting goals of consumption and production of components too low will lead to a decreased reuse rate. In the area of consumption and production costs of reusable components, production costs are more critical. Regarding employee turnover, reuse is enhanced by a low rate of turnover of personnel. In establishing a successful reuse program, creating a repository is an important factor and the study indicates there is a structurally stable repository value. Concerning the software development rate of components, a steady development rate leads to a more consistent reuse rate. DoD managers can now use these results in formulating policies concerning their systematic software reuse program.

KNOWLEDGE DISCOVERY USING GENETIC PROGRAMMING

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Dramatic growth in database technology has outpaced the ability to analyze the information stored in databases for new knowledge and has created an increasing potential for the loss of undiscovered knowledge. This potential gains for such knowledge discovery are particularly large in the Department of Defense where millions of transactions, from maintenance to medical information, are recorded yearly. Due to the limitations of traditional knowledge discovery methods in analyzing this data, there is a growing need to utilize new knowledge discovery methods to glean knowledge from vast databases. This research compares a new knowledge discovery approach using a genetic program (GP) developed at the Naval Postgraduate School that produces data associations expressed as IF X THEN Y rules. In determining validity of the GP approach, the program is compared to traditional statistical and inductive methods of knowledge discovery. Results of this comparison indicate the viability of using a GP approach in knowledge discovery by three findings. First, the GP discovered interesting patterns from the data set. Second, the GP discovered new relationships not uncovered by the traditional methods. Third, the GP demonstrated a greater ability to focus the knowledge discovery search towards particular relationships, such as producing exact or general rules.

ANALYSIS, DESIGN AND IMPLEMENTATION OF A DATABASE SYSTEM FOR THE SYSTEMS MANAGEMENT CURRICULUM OFFICE

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and
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The Systems Management Curricular Office at the Naval Postgraduate School is burdened with the enormous administrative task of managing files for over 500 students. In a time of drastic military downsizing and funding cuts, this task will require more work of a smaller staff with less money. The burden of paper management could be lessened through automation of record keeping, while increasing efficiency and effectiveness. Valuable time for the students could be saved through elimination of excessive paperwork which they were required to prepare. Based on requirements from the Systems Management Curricular Office, this thesis designs and implements a database management system. The primary objective is to allow the incoming class of students to enroll using this system instead of traditional paper forms, enabling the staff to focus on more non-administrative tasks. This system will store, sort and compare data relevant to all students while minimizing the need to maintain hardcopy files. Additionally, the staff will be able to query reports and generate letters with minimal effort. The system is also analyzed to determine possible enhancements that could be added in the future. The Systems Management Database Systems (SMDS) is designed using Borland's PARADOX version 4.0.

AN EVALUATION OF B-ISDN FOR THE COMMUNICATION ARCHITECTURE REQUIREMENTS OF DISTRIBUTED INTERACTIVE SIMULATION (DIS)

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Distributive Interactive Simulation (DIS) requires a communication architecture to support large scale simulations (100,000 entities). This communication architecture requirements for DIS are not being defined. DIS will require a wide area network that supports high data rates, multicasting and low latency. DoD can no longer afford unique solutions for their wide area networking needs and must align their service requirements with the services provided by common carriers. An analysis is presented on how the future Broadband Integrated Services Digital Network (B-ISDN) and its technology standard, Asynchronous Transfer Mode (ATM), could help meet the WAN communication architecture requirements of DIS. The requirements of DIS are presented and mapped into a format compatible with international standards for common carrier services. Quality of Service (QoS) parameter values for DIS information types are estimated and compared to those of B-ISDN. Conclusions reveals that B-ISDN and its underlying technology, ATM, will help meet the DIS WAN communication architecture needs. Also, QoS parameter values for DIS require further definition and specificity to enable DoD to take advantage of the future common carrier services. DoD needs to define its future application requirements to enable the use of future public communication networks. The method presented can be used to define existing and future application requirements that are compatible with common carrier services.

DISTANCE EDUCATION: A CASE STUDY WITH APPLICATIONS FOR DOD AND THE MARINE CORPS

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This thesis is a qualitative analysis in the field of distance education. The author's research first established what technology is required for an organization to engage in distance education. Next, an argument was made through interviews throughout DoD and the Marine Corps indicating that implementation of distance education required strategic thinking and vision. Standardizing, outsourcing, and prototyping contribute towards effective implementing. Finally, a case study was conducted using a grounded theory approach with primary users of videoteletraining (VTT) from the Defense Language Institute of Monterey, CA. The goal of this research was to find common themes created from three focus groups concerning user reactions towards VTT. Important concepts emerged corroborating positive implementation theories: VTT instructors adapt quickly to the medium, VTT bridges the distance gap between student and teach, and VTT encourages instructors to grow as managers of the medium. Overall, distance education is viewed as a viable option for DoD and the Marine Corps.

AN EXPERIMENTAL INVESTIGATION OF TIME DELAYS IN SOFTWARE PROJECT STAFFING

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Failing software development projects are plaguing the Department of Defense and other Federal service agencies today. Compounding this fact, the complexity of today's software projects makes it extremely difficult to isolate the underlying problem areas. The System Dynamic Model (SDM), a quantitative tool that simulates software development life cycles, enables us to investigate these problem areas as well as many other pertinent areas. It allows the isolation and manipulation of management variables have on projects. This thereby uses this System Dynamic Model's gaming interface to investigate the effects of time delays on software project management. Specifically, this experiment focuses on how software project managers compensate for assimilation and hiring delays inherent to a single project environment. The effect of these delays are measured in terms of staffing level decisions, final cost, and project completion.

AUTOMATIC IDENTIFICATION TECHNOLOGY (AIT): THE DEVELOPMENT OF FUNCTIONAL CAPABILITY AND CARD APPLICATION MATRICES

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Automatic identification technology (AIT), also known as automated data collection (ADC) technology, has been in use in various industry and government applications. The present AIT resources are magnetic ink character recognition, optical character recognition, bar code, magnetic stripe, radio frequency, optical laser memory, integrated circuit (IC), biometric and voice data collection, and machine vision. Smart card, super smart card, and magnetic memory card technology (e.g., PCMCIA) are integrated circuit technology. Personnel selecting, acquiring, implementing and using these technologies should possess a knowledge of the capabilities and applications of the AIT resources to obtain the best AIT system to meet their mission requirements. In order to facilitate an understanding of the AIT resources and their applications, two matrices were developed. An AIT Functional Capability Matrix was developed to identify and assess the capabilities of the AIT resources. An AIT Card Application Matrix was developed to identify and assess the capabilities of the AIT resources. An AIT Card Application Matrix was developed to identify the automation of various applications with these technologies. The matrices can assist system designers, system integrators, information system management personnel, users, and consumers of AIT resources understand the functional capabilities and the applications of these technologies in a concise format. The matrices can be used for selection and acquisition of AIT systems and to track and address migration of the AIT systems throughout their life cycles.

COMPUTER-BASED MULTIMEDIA PROTOTYPE FOR NIGHT VISION GOGGLES

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and
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B.S., University of Southern California, 1987
Master of Science in Information Technology Management-September 1994
Advisors: Kishore Sengupta and Alice Crawford-Department of Systems Management

Naval aviators who employ night vision goggles (NVG) face additional risks during nighttime operations. In an effort to reduce these risks, increased training with NVGs is suggested. Our goal was to design a computer-based, interactive multimedia system that would assist in the training of pilots who use NVG multimedia prototype. It describes which hardware components and software applications were utilized as well as how the prototype was developed. Several facets of multimedia technology (sound, animation, video and three dimensional graphics) have been incorporated into the interactive prototype. For a more robust successive prototype, recommendations are submitted for future enhancements that include alternative methodologies as well as expanded interactions.

A SURVEY OF THE SOFTWARE REUSE ENVIRONMENT: A STUDY FOR THE NSRS

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This study investigates the needs of software developers in the area of software reuse. The study formulates recommendations on how a software repository can meet the needs of the software development community. The Naval Software Reuse System (NSRS) is the focus of this research and the findings are intended for their use. The study focuses on eight core questions that are the central issues for the NSRS. On the basis of these eight core questions, a survey was developed that elicited the opinions of software developers. The analysis of the survey provides conclusions for seven of the eight core questions. These conclusions lead to recommendations that for the most part are completely within the control of Naval Computers and Telecommunications Station (NCTS) Washington. NCTS Washington is the agency presently building the NSRS.

KNOWLEDGE QUALITY FUNCTIONS FOR RULE DISCOVERY

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The Department of Defense (DoD) possesses tremendous amounts of data stored in many large databases. Due to the size of these databases, humans are incapable of efficiently discovering interesting and useful patterns so an automated data-mining tool is necessary. Output in the form of production rules, i.e., "If y Then x," is preferred because they are understandable by humans and support decision making processes. This thesis investigates the manner in which data-mining systems discover useful, interesting, but currently unavailable knowledge. The search and evaluation process, guided by a knowledge quality function, is the key task of a data-mining system. This thesis evaluates three knowledge quality functions taken from the literature. Each knowledge quality function discovers new and interesting sets of rules reflecting different characteristics of knowledge. DoD applications are suggested for each of the knowledge quality functions.

SECURE DISTRIBUTED FILE SYSTEMS

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and
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Secure information distribution is a strategic capability as significant as weapons systems and tactics to military operations. The Department of Defense has recognized the importance of establishing and maintaining secure distributed communications between automated information systems. This research reviews eleven different distributed file systems and explores the practicality and applicability of one such system, Trusted Ficus File System (TRUFFLES), in the DoD infrastructure. Integrated into this research are discussions of Privacy Enhanced Mail (PEM), which is currently an integral part of the TRUFFLES implementation. This thesis concludes with a discussion of the actual installation of a PEM reference implementation, and future requirements for the TRUFFLES installation at the Naval Postgraduate School.

COMPACT DISK TECHNOLOGY AND THE CONCERNS OF ATLANTIC FLEET SURFACE FORCES COMMANDING OFFICERS

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This thesis deals with the concepts of Compact Disk (CD) technology, OPNAV INST 5230, and the concerns of the Commanding Officers of the Surface Forces of the Atlantic Fleet. OPNAV INST 5230 is the Navy and Marine Corps guidance on the implementation of CD technology. Review of current literature indicates the minimum requirements of the instruction are insufficient. Methods of improvements are discussed. Using the Systems Development Life Cycle as a framework, three methods of implementing CD-ROM technology are proposed. Management concerns are addressed, specifically, resistance to change when implementing a new technology. An economic analysis is also included. Commanding Officers of surface ships are surveyed to determine the extent of CD usage on ships, the types of training involved with their usage, concerns over the systems and the desire to participate in a pilot program should one be funded.

AN EVALUATION FRAMEWORK FOR DESIGNING A NIGHT VISION, COMPUTER-BASED TRAINER

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The mission requirement of low-level, nighttime navigation employing night vision goggles has expanded. This has led to a greater demand for training NVG skills and initiated a requirement for a low-cost, desktop, computer-based trainer (CBT). A framework is presented in this thesis that includes a review of the technology available for designing a night vision CBT. System attributes and constraints are identified and analyzed, and evaluation criteria developed to allow for examination of alternative system configurations. Two configurations are developed: one PC-based and one workstation-based. These configurations present different cost/benefit components. A sample inspection in graphics capabilities, processor performance and peripheral support is provided for the two configurations. In addition, cost range estimates are included and baseline capabilities established to assist in the determination process.

SCHEMA AND DATA CONFLICT RESOLUTION ACROSS DISTRIBUTED GRAPHICAL ASN.1 DATABASES

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Recently, most large corporations, including Department of Defense and the Department of the Navy, have seen dramatic proliferation of incompatible databases and their associated database management systems. Sooner or later, these organizations discover the need to integrate the data in these incompatible databases. One solution to this problem is the use of markup languages like Abstract Syntax Notation One (ASN.1) as a standard format for representing these databases and output reports and thus facilitating their integration. A main requirement of this integration approach is the ability to correctly identify and resolve the semantic conflicts that arise in the marked-up databases and outputs of software tools before any integration can take place. This thesis addresses this issue by introducing a systematic approach for identifying and resolving semantic conflicts for these databases and developing a prototype tool that aids in this resolution. We hope that this tool will greatly aid in efforts of integration and manipulation of ASN.1 databases.

DESIGN AND IMPLEMENTATION OF A PROTOTYPE MONITOR ASSIGNMENT SUPPORT SYSTEM (MASS)

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A primary mission for the Manpower Management Officer Assignment (MMOA) Branch of Headquarters, United States Marine Corps (HQMC) is the placement of trained and qualified officers into authorized billets both internal and external to the Marine Corps. In accomplishing their mission, the monitors and their support staff rely on a variety of information sources to assist them in their decision making. Access to this information, however, is neither quick nor easy and too much reliance is placed on paper reports and microfiche, which are often outdated. To remedy this situation, this thesis develops a prototype PC-based Monitor Assignment Support System (MASS) to assist monitors in their day to day activities. The focus of this thesis is on the development of the assignment process model and its implementation into a database application. The prototype downloads updated personal and performance information about an officer which is used by a Marine monitor to make assignment decisions. MASS was developed using Microsoft Access database management system which proved to be a powerful and easy to use tool for developing this prototype.

A COMPARATIVE STUDY OF COMMERCIAL AND DEPARTMENT OF DEFENSE STRATEGIES FOR DEVELOPING SOFTWARE APPLICATIONS

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A focus on information system application development is on the rise as users become more familiar with the computing environment and the business advantages it gives the organization. Enormous software development backlogs and increasing demand for application software are forcing information system managers to look at new and innovative ways to develop and maintain software. High-level software languages and tools are being introduced into organizational information system development environments. Software languages and tools that are being used to build systems quickly and effectively by leading-edge organizations are fourth-generation languages, computer-aided software engineering tools, and object-oriented technologies. Results of a survey of 23 information system executives that accompany this thesis provide evidence that organizations are moving rapidly toward these languages and tools, and continue to shift their emphasis away from older conventional development methodologies and line-by-line coding of procedural programming languages. The Department of Defense should revise its own policies and practices where appropriate to conform to the clear trends emerging in leading private-sector organizations.

SECURE DISTRIBUTED FILE SYSTEMS

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and
Winslow H. Buxton-Lieutenant, United States Navy
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Secure information distribution is a strategic capability as significant as weapons systems and tactics to military operations. The Department of Defense has recognized the importance of establishing and maintaining secure distributed communications between automated information systems. This research reviews eleven different distributed file systems and explores the practicality and applicability of one such system, Trusted Ficus File System (TRUFFLES), in the DoD infrastructure. Integrated into this research are discussions of Privacy Enhanced Mail (PEM), which is currently an integral part of the TRUFFLES implementation. This thesis concludes with a discussion of the actual installation of a PEM reference implementation, and future requirements for the TRUFFLES installation at the Naval Postgraduate School.

THE ADDED VALUE OF QUALITATIVE VARIABLES IN A QUANTITATIVE MANPOWER MODEL FOR DOD MTF IS DEPARTMENTS

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Because of concern over the budget deficit and the end of the Cold War, the Department of Defense (DoD) has become the target of massive downsizing. As a result, the justification of manpower levels through the use of manpower models has become increasingly important. This thesis addresses those qualitative/unquantifiable factors in the DoD Medical Treatment Facility (MTF) Information Systems (IS) environment that should be considered in the development of a manpower model or staffing standard for a DoD MTF IS department. These factors include DoD's movement to the managed/coordinated care environment, a macro versus a micro approach model development, model flexibility, cost-effectiveness, and consistency, as well as the usefulness of the model for planning purposes. The various models or methodologies employed by the Army, Navy, and Air Force to staff their respective MTF IS departments are evaluated in light of these factors. Because they are difficult to quantify, qualitative factors are frequently overlooked. They do, however, contribute to model effectiveness, efficiency and longevity in that they consider some of the broader climatic concerns a mathematical formula often omits, and should be incorporated into the model building process.

COMPUTER-BASED MULTIMEDIA PROTOTYPE FOR NIGHT VISION GOGGLES

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Naval aviators who employ night vision goggles (NVG) face additional risks during nighttime operations. In an effort to reduce these risks, increased training with NVGs is suggested. Our goal was to design a computer-based, interactive multimedia system that would assist in the training of pilots who use NVG multimedia prototype. It describes which hardware components and software applications were utilized as well as how the prototype was developed. Several facets of multimedia technology (sound, animation, video and three dimensional graphics) have been incorporated into the interactive prototype. For a more robust successive prototype, recommendations are submitted for future enhancements that include alternative methodologies as well as expanded interactions.

MODELS OF REQUIREMENTS TRACEABILITY IN SYSTEMS MANAGEMENT

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The Department of Defense Standard 2167A mandates that requirements traceability be conducted during the development of Government software systems. However, a comprehensive model of what and how information should be captured in a traceability scheme does not exist. In the absence of such a model, the quality and content of traceability information captured in current practice varies widely with much information outdated, irrelevant and useless. The objective of this research is to develop the framework for the development of components of a comprehensive model of Requirements Traceability. The two components addressed are the Requirements Management Model and the Design Allocation/Implementation Model. These models define what types of information needs to be captured and maintained during the requirements management and design allocation/implementation stages of systems development. Additionally, traceability is an expensive activity often involving effort earlier in the lifecycle with potential benefits occurring later in the lifecycle. This paper identifies factors to be considered in an analysis of technical, economic and operational feasibility of implementing a comprehensive requirements traceability scheme.

THE VERIFICATION AND VALIDATION OF THE MK 92 MOD 2 FIRE CONTROL SYSTEM MAINTENANCE ADVISOR EXPERT SYSTEM

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Verification and validation is the common name for a quality assurance process that is used in the development of software. The goal of verification and validation is to ensure that the developed software is complete and correct. It has been shown that the cost to correct software errors is orders of magnitude higher at the end of the development. This thesis describes the process for verifying and validating the MK 92 MOF 2 Fire Control System (FCS) Maintenance Advisor Expert System (MAES). A literature review was performed to assimilate the background knowledge with which to develop a framework for conducting the verification and validation. The framework is a general guide which could be used in the verification and validation process for DoD expert systems developed in a like environment, i.e., using an expert tool with similar knowledge representation schemes. Using the framework, a specific verification and validation plan was developed

MODELS OF REQUIREMENTS TRACEABILITY IN SYSTEMS MANAGEMENT

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The Department of Defense Standard 2167A mandates that requirements traceability be conducted during the development of Government software systems. However, a comprehensive model of what and how information should be captured in a traceability scheme does not exist. In the absence of such a model, the quality and content of traceability information captured in current practice varies widely with much information outdated, irrelevant and useless. The objective of this research is to develop the framework for the development of components of a comprehensive model of Requirements Traceability. The two components addressed are the Requirements Management Model and the Design Allocation/Implementation Model. These models define what types of information needs to be captured and maintained during the requirements management and design allocation/implementation stages of systems development. Additionally, traceability is an expensive activity often involving effort earlier in the lifecycle with potential benefits occurring later in the lifecycle. This paper identifies factors to be considered in an analysis of technical, economic and operational feasibility of implementing a comprehensive requirements traceability scheme.

ESTABLISHING A CHARGEBACK POLICY: WHAT THE DEPARTMENT OF DEFENSE CAN LEARN FROM ONE COMPANY'S APPROACH

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A large California-based computer and electronics manufacturer is currently consolidating its Information Technology Centers. This thesis addresses the problems the company is experiencing with implementing the consolidation and developing the chargeback scheme which will be used. The Department of Defense (DOD) is currently consolidating its own data processing centers and instituting a fee-for-service (chargeback/cost recovery) policy. This thesis will highlight some of the problems DOD will encounter in instituting its own cost recovery policies and other major organizational change. This thesis addresses the company's chargeback dilemma by first analyzing the strengths and weaknesses of several common chargeback techniques. It then critically evaluates the process by which the company is managing the transition and the method it is using to institute its chargeback policy. Finally, the thesis discusses the lessons DOD can learn from this study of a private sector approach to chargeback.

PERSONAL COMPUTER AND WORKSTATION OPERATING SYSTEMS TUTORIAL

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Advisor: Norman F. Schneidewind-Department of Systems Management

This thesis is a review and analysis of personal computer and workstation operating systems. The emphasis is placed on UNIX, MS DOS, MS Windows and OS/2 operating systems. UNIX is covered under the U.S. Government POSIX standard, which dictates its use when practical. MS DOS is the most used operating system worldwide. OS/2 was developed to combat some of the shortcomings of MS DOS. Each operating system which is discussed has a design philosophy that fulfills specific user's needs. UNIX was designed for many users sharing a computer system. MS DOS, MS Windows and OS/2 are designed as single user computer systems. All of these operating systems are in use at the Naval Postgraduate School. All of the operating systems are discussed with regard to their: history of development, process management, file system, input and output system, user interface, network capabilities, and advantages and disadvantages. UNIX has a section devoted to t he POSIX standard and MS DOS has a section devoted to Windows 3.1. Apple Corporation's System 7 is mentioned throughout the text, but is not covered in detail.

KNOWLEDGE BASE DEVELOPMENT IN RADIANT MERCURY FOR SHIPBOARD USE

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Currently, classified contact messages are manually sanitized causing significant delays in disseminating the information. The primary mission of Radiant Mercury is to automatically sanitize formatted classified contact messages. To do this, a knowledge source or "expertise" is required. This thesis develops a knowledge base that can be used within Radiant Mercury for automated shipboard message dissemination. The details of the knowledge acquisition process for building the knowledge base are presented. Logic flowcharts and rules are developed describing the message dissemination process from unclassified to top secret. In order for this thesis to be unclassified, some of the rules could not be discussed. This thesis concludes with recommendations for further study that involve enhancing the knowledge base.

A DESIGN RATIONALE CAPTURE USING REMAP/MM

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Master of Science in Information Technology Management-June 1994
and
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Every year the Department of Defense (DoD) spends between 24 and 32 billion dollars on software alone, with maintenance costs comprising the majority of this figure. Recent studies have indicated that an effective solution to help curtail development and maintenance costs is to capture the rationale behind systems requirements and designs, and use this information throughout the life cycle. This thesis explores the use of REMAP/MM and multimedia based design rationale management systems. Based on a case study, a detailed example illustrating to use REMAP/MM in various systems development activities is presented.

A SYSTEM DYNAMICS BASED STUDY OF SOFTWARE REUSE ECONOMICS

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Advisor: Tarek Abdel-Hamid-Department of Systems Management

Software productivity is a critical issue for Government agencies and the Department of Defense. Satisfying the enormous demand for new software and reducing cost creates pressure to develop new software production techniques. Of these, one of the most promising, strongly supported by Government and DoD agencies, is software reuse. This thesis studies the economics of software reuse using a system dynamics computer model, he Dynamica Reuse Model, which simulates the activities of a software development organization engaged in organization-wide, systematic software reuse. Long-term relationships between reuse rate, productivity, and unit cost are studied by varying consumption cost, production cost, employee turnover rate, and reusable component retirement age. Results suggest long-term steady state relationships may be different from short-term dynamic state relationships. After validation and customization the Dynamica Reuse Model can be used to support an organization's cost and schedule software tools. Increasing understanding of the software development process in order to make knowledgeable rather than intuitive predictions about organizational variables related to reuse such as reuse rate, productivity, and unit cost, enable the model to serve as a management support tool for the complex and costly process of software development.

AN ANALYSIS OF INTERNET'S MBONE:
A MEDIA CHOICE PERSPECTIVE

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B.S., St. Cloud State University, 1986
Master of Science in Information Technology Management-September 1994
Advisor: James E. Suchan-Department of Systems Management

This thesis examines the perceived effectiveness of Internet's Multicast Backbone (MBONE) compressed-motion video-teleconferencing system and analyzes its capabilities and limitations. The analysis follows the media richness model of media choice and discusses seven influences on a managers' media selection. This study expands the video-teleconferencing branch of the continuum of communication media to include compressed-motion video-teleconferencing and the distinguishing factors between systems. The study uses data gathered from the Monterey Bay Aquarium Research Institute's (MBARI) Internet conference experiment to compare MBONE versus face-to-face viewer perceptions of the different communication media and to support the theoretical analysis. The survey instrument used to gather data is presented in this thesis. Research results showed that the compressed-motion video image of MBONE filtered and restricted the conveyance of some non-verbal cues and that feedback could be delayed in one-to-many situations. MBONE is found to be more effective for reducing uncertainty than resolving equivocal communication situations. This framework for analysis will enable those responsible for the selection of communication media within the Department of Defense (DoD) to have a basis for distinguishing between choices of video-conferencing systems.

DESIGN AND IMPLEMENTATION OF THE CALIBRATION MODULE OF THE MK 92 PROTOTYPE MAINTENANCE ADVISOR EXPERT SYSTEM

David M. Geick-Lieutenant, United States Navy
B.A., University of New Hampshire, 1985
Master of Science in Information Technology Management-March 1994
and
Steven E. Mikler, Lieutenant, United States Naval Reserve
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Master of Science in Information Technology Management-March 1994
Advisors: Magdi Kamel and Martin J. McCaffrey-Department of Systems Management

This thesis is the continuation of a software project to develop a diagnostic expert system for the MK92 Fire Control System based on the Daily System Operability Test (DSOT). The focus of this work is on the design and implementation of the calibration portion of the expert system using the Adept visual programming expert system shell. The calibration module is designed as a top-down hierarchy of cohesive, loosely coupled procedures. These procedures are linked through two-way links. This modular, structured design resulted in a compact system that is easy to read, modify, maintain, and test. Many of the logical troubleshooting paths are implemented using common procedures with variables, reducing application size and recognizing the expert's use of identical logic to isolate problems in different areas of the MK92 system. The calibration module fulfills the design and functional objectives set by the project team and project sponsor. Preliminary testing shows the module to be successful in MK92 DSOT calibration fault isolation.

THE COMMUNICATIONS TOOLBOX FOR MATLAB AND EO 3513 LABORATORY DESIGN

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Master of Science in Information Technology Management-March 1994
Advisor: Randy L. Borchardt-Department of Electrical and Computer Engineering

EO 3513, Communications Systems Engineering II: Modulation, is the second of a three-course sequence for students in the C3, Space Systems Operations, and Information Technology Management curricula at the Naval Postgraduate School in Monterey, California. This course presents a review of Fourier methods and covers analog and digital communications systems. The identified need for computer laboratories to support EO 3513 results in the development of a set of 34 functions collectively called the Communications Toolbox for use with MATLAB. The Communications Toolbox contains functions that, when linked together, simulate the output of various communications systems. Developed in association with the Communications Toolbox are two sets of laboratories: nine computer-aided laboratories (tutorial in nature), and fourteen programming laboratories. Laboratory and toolbox development are described and documented, with additional notes on design, testing, and implementation. The complete laboratory sets, with answer keys, User's Guide, and computer code for toolbox functions, are provided.

AN EVALUATION OF TRACEABILITY TOOLS

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The government mandates that requirement traceability be conducted during the development of computer based systems. Capturing all the information necessary to satisfy the traceability needs of various stakeholders during the system development is an enormous task. Computer Aided System Engineering (CASE) tools ease the burden of this task. However, as CASE tools differ widely in their functionalities, it has become a formidable task for organizations to select the tool that best fits their needs. The goal of this research is to develop an approach that can be used to assist an organization in evaluating requirement traceability tools. The various characteristics that should be considered are defined and discussed. This thesis also investigates some of the current commercial requirement traceability tools and discusses their capabilities and limitations.

ANALYSIS, DESIGN AND IMPLEMENTATION OF A DATABASE SYSTEM FOR THE SYSTEMS MANAGEMENT CURRICULUM OFFICE

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and
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The Systems Management Curricular Office at the Naval Postgraduate School is burdened with the enormous administrative task of managing files for over 500 students. In a time of drastic military downsizing and funding cuts, this task will require more work of a smaller staff with less money. The burden of paper management could be lessened through automation of record keeping, while increasing efficiency and effectiveness. Valuable time for the students could be saved through elimination of excessive paperwork which they were required to prepare. Based on requirements from the Systems Management Curricular Office, this thesis designs and implements a database management system. The primary objective is to allow the incoming class of students to enroll using this system instead of traditional paper forms, enabling the staff to focus on more non-administrative tasks. This system will store, sort and compare data relevant to all students while minimizing the need to maintain hardcopy files. Additionally, the staff will be able to query reports and generate letters with minimal effort. The system is also analyzed to determine possible enhancements that could be added in the future. The Systems Management Database Systems (SMDS) is designed using Borland's PARADOX version 4.0.

RECRUITMENT STRATEGIES FOR DOD INFORMATION TECHNOLOGY MANAGERS

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Master of Science in Information Technology Management-September 1994
Advisor: Barry A. Frew-Department of Systems Management

Information technology (IT) continues to rapidly change in an unpredictable manner. DoD's success in responding to its mission, given a sure reduction in resources, will be determined largely by how well it leverages information technologies. DoD IT professionals must provide guidance and leadership in the use of IT as a leveraging tool. DoD has not defined the roles for, or desired characteristics of, its IT professional or work force. Without these definitions, appropriate selections of people into IT positions will be even more difficult. Some HRO programs, initiated to deal with reductions of personnel, have biased the selection of federal government job candidates so that it is difficult to select the best suited, and sometimes even a qualified, candidate. This is particularly troublesome because of the breadth, speed and unpredictable nature of change within IT technologies. This thesis suggests methods for dealing with issues that improve the likelihood of selecting the best candidate for an IT position. It also describes desired characteristics of an IT professional that should be the focus of recruiting efforts and provides recommended interview questions and a skills checklist for use in the recruiting process. It identifies methods for improving recruitment results using today's rules and also suggests ways to change the existing system to get more consistent results when matching candidates with IT professional positions.

MULTIDIMENSIONAL SCALING OF USER INFORMATION SATISFACTION

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The objective of this study was to determine if multidimensional scaling reveals more about user perception of satisfaction with information systems than did factor analysis. Multidimensional scaling shed a different light on information satisfaction data, making them easier to visualize and interpret. While the differences were not substantial between multidimensional scaling and factor analysis, we concluded that the possibility of remarkably new insights gained through multidimensional scaling were well worth the small marginal cost of undertaking the analysis. Multidimensional scaling (MDS) provides an information technology (IT) manager with possible new perspectives in the analysis of user's satisfaction with information and with information systems. The technique probes for meanings locking in user satisfaction data that are not accessible by other analytic procedures. IT managers should be, in all cased, skeptical of contrived hypothesis testing and factor analyses that deal with satisfaction data only at its face value. MDS gives managers a tool by which they can identify meanings beyond the obvious. Coupled with the careful and effective use of the semantic differential question format, MDS is a powerful means to escape the fatal flaw in data gathered by survey questionnaires: socially desirable responses.

INFORMATION NEEDS ASSESSMENT OF THE PATUXENT RIVER NAVAL HOSPITAL

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and
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Advisors: William B. Short and Myung W. Suh-Department of Systems Management

The Patuxent River Naval Hospital is examining methods to provide the highest quality and access to care at the lowest cost possible. To do this, a number of data or information needs must be identified. It is the purpose of this thesis to identify Patuxent River Naval Hospital's information needs. A research method is applied to capture these information needs. Interviews with key managers reveal a number of Critical Success Factors (CSF). These CSFs are: Access to Quality Care and Service, Management of Financial Resources, Management of Physical Resources, and Management of Human Resources. Under each CSF, a number of functional needs are identified, with each being tied to a number of effectiveness measures. From these effectiveness measures, the information needs of the organization emerge. The identified information needs are examined against the existing information systems capabilities. A frame work is developed for examining the information needs of the Patuxent River Naval Hospital. Many of the identified information needs do not exist in the current information systems and recommendations are provided on how to fill the gaps.

INTELLIGENT TUTORING SYSTEMS: A DESIGN SUPPORT TOOL

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Advisor: Kishore Sengupta-Department of Systems Management

The Department of Defense (DoD) is facing a shortage of qualified instructors for its advanced technical weapons training facilities. This shortage is because of the current downsizing trend, without a similar trend in the development of weapons and computer systems. To maintain a force of highly trained, technical personnel, DoD must investigate other methods for training and maintaining a highly technical force. The advanced capabilities of modern computer systems with the use of Intelligent Tutoring Systems (ITS) can provide a supplemental training aid for the lack of human instructors. This thesis proposes the use of a Design Support Tool (DST) to assist instructional designers in the development of ITS systems for the DoD.

UNIX BASED MULTIMEDIA PROTOTYPE FOR THE NAVY'S 76mm GUN

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Interactive learning systems (ILS) will have a significant impact on the future of military education and training. Research has shown that these systems are a technically viable and realistic alternative for maintaining operational readiness. This thesis describes the development of a multimedia instruction system for the Navy's 76mm gun. It includes examples from the prototype in its first stages of development. Critical success factors for effective development of multimedia systems are provided.

A STRUCTURED APPROACH TO INFORMATION TECHNOLOGY MANAGEMENT IN THE DEPARTMENT OF DEFENSE

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Information technology management (ITM) in the Department of Defense (DoD) has changed significantly during the 1980's and early 1990's. The pace of this change seems to only be accelerating as computer processing power continues to increase, data storage and retrieval capacity continues to grow, telecommunications capabilities continue to improve, hardware and software become more readily available, and automation costs continue to decrease. Managers need to understand the answers to the following questions in order to manage DoD IT effectively and efficiently: 1) What impact are the Information Age and the Military Technical Revolution having on the DoD? 2) How can managers engineer and manage IT in the DoD more effectively and efficiently? and 3) What new applications of IT are now possible in the DoD? The author created and tested in class a course designed to help prepare military personnel and defense civil servants (DoD civilians) to serve as technical managers of defense-related IT. The course uses an integrated set of learning materials that provides answers the three questions presented above. Material covered by the course includes: Module 1 - The Military Technical Revolution: The Changing DoD IT Environment, Module 2 - A Structured Approach to ITM in the DoD: The Structured Approach Framework, Module 3 - A Structured Approach to ITM in the DoD: The Structured Approach Process, and Module 4 - Command and Control Warfare: An Application of ITM in the DoD.

SMOOTHER SAILING AHEAD: INTEGRATING INFORMATION TECHNOLOGY INTO THE SURFACE NAVY

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Organizations incorporate changes in technological capabilities and patterns of work slowly and with great difficulty. Similar to the introduction of electricity in the early 1990's, information technology's benefits were not realized until competition forced private companies to adapt their organizational structure and operating practices to take advantage of new capabilities. They sought to change the very nature of work, not just do work faster. A decreasing defense budget forces the Navy to face many of the common problems overcome earlier in the world of private industry. This initial exploration identifies potential opportunities to be gained by taking a business perspective in the integration of information technology in the evolution to smaller, more capable, less manpower-intensive surface ships.

AN ARCHITECTURAL APPROACH TO INFORMATION SYSTEMS PLANNING FOR THE OFFICE OF NAVAL INTELLIGENCE (ONI)

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Strategic information systems (IS) planning aligns an organization's information systems with its critical strategic goals and supporting mission-specific functions. This thesis demonstrates a structured approach to strategic IS planning and provides a guide for developing an information systems architecture to support the organizational goals of the Office of Naval Intelligence (ONI). By first examining established information systems planning practices, architectural design methodologies, Department of Defense (DoD) guidelines, and published ONI organizational objectives, this thesis guides the reader through the decision-making process involved in strategic IS planning. The methodology is structured on guidance provided by the DoD's Technical Architecture Framework for Information Management (TAFIM) Standards-Based Architecture (SBA) Planning Guide. This thesis demonstrates the validity of using the structured architectural approach, presented by the FAFIM and other strategic IS planning concepts, in concert with intelligence-specific IS planning guidance to systematically address the issue, problems, and critical decision faced by organization attempting the strategic IS planning process.

IMPLEMENTATION OF THE PRODUCTION VERSION OF THE PERFORMANCE AND CALIBRATION MODULES OF THE MK 92 MOD 2 FIRE CONTROL SYSTEM MAINTENANCE ADVISOR EXPERT SYSTEM

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The MK92 Mod 2 Fire Control Systems (FCS) is a complex, maintenance intensive shipboard weapon system primarily found aboard the Oliver Hazard Perry class fast frigates (FFG-7). A maintenance advisor expert system (MAES) is being developed by the Port Hueneme Division of the Naval Surface Warfare Center and the Naval Postgraduate School (NPS) to assist the Fire Control Technicians aboard ship to better isolate faults in the MK 92 Mod 2 FCS. This thesis furthers the efforts of the project at NPS by investigating key hardware and software implementation issues that involve the deployment of the MAES to the fleet. Additional deployment issues addressed in this thesis include software documentation, integration of Performance and Calibration Modules, and the feasibility of the MAES being used as a training aid.

A PROTOTYPE OF A FACULTY AND STAFF EXECUTIVE INFORMATION SYSTEM

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Master of Science in Information Technology Management-March 1994
Advisor: Shu S. Liao-Department of Systems Management

Design, development, and implementation of the Naval Postgraduate School Faculty and Staff Resume Book is outdated and not well maintained. This EIS system provides the Office of the Dean of Research a "paperless" solution that is easy to use, update, and maintain. Asymetrix's Multimedia ToolBook software authoring package is technically capable and well suited to handle the large amounts of faculty data that the Resume Book contains. Using graphical user interface (GUI), buttons, and hypernavigation allows easy access to desired information. The Naval Postgraduate School Faculty and Staff Resume Book EIS system is a solid foundation on which to examine the capabilities of multimedia technology. It provides an excellent opportunity for the Naval Postgraduate School to become a leader in this dynamic field.

APPLYING MULTIMEDIA TO THE MK 92 MOD 2 MAINTENANCE ADVISOR EXPERT SYSTEM

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This thesis is part of a software project to develop a diagnostic expert system for the MK 92 Mod 2 fire control system (FCS) daily system operability test (DSOT). The focus of this work examines the feasibility of applying multimedia, in the form of graphics, digital video, sound, and CD-ROM technology, to the MK 92 Mod 2 Maintenance Advisor Expert System (MAES). The MAES application is intended for distribution to fleet sailors in order to increase readiness of the MK 92 Mode 2 FCS and decrease the need for outside technical assistance. The MAES application is intended for distribution to the fleet on portable computers. In its current form, the MAES includes only text-based procedures and instructions to aid the user. This study examines whether it is technically feasible to employ high-resolution images, digital video, and sound to enhance the MAES and add impact to the current text outputs. Additionally, it explores the costs associated with each media. Given that the MAES will operate on a portable computer, the study also examines the limitations a portable environment places on multimedia technologies. Finally, this study recommends specific instances of incorporating multimedia in future implementations of the MAES.

DESIGN AND IMPLEMENTATION OF THE CALIBRATION MODULE OF THE MK 92 PROTOTYPE MAINTENANCE ADVISOR EXPERT SYSTEM

Steven E. Mikler, Lieutenant, United States Naval Reserve
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This thesis is the continuation of a software project to develop a diagnostic expert system for the MK92 Fire Control System based on the Daily System Operability Test (DSOT). The focus of this work is on the design and implementation of the calibration portion of the expert system using the Adept visual programming expert system shell. The calibration module is designed as a top-down hierarchy of cohesive, loosely coupled procedures. These procedures are linked through two-way links. This modular, structured design resulted in a compact system that is easy to read, modify, maintain, and test. Many of the logical troubleshooting paths are implemented using common procedures with variables, reducing application size and recognizing the expert's use of identical logic to isolate problems in different areas of the MK92 system. The calibration module fulfills the design and functional objectives set by the project team and project sponsor. Preliminary testing shows the module to be successful in MK92 DSOT calibration fault isolation.

DESIGN AND IMPLEMENTATION OF A DATA MODEL FOR THE PROTOTYPE MONITOR ASSIGNMENT SUPPORT SYSTEM

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This thesis is part of a project whose overall objective is to provide monitors in the United States Marine Corps a user-friendly PC-based database system, called the Monitor Assignment Support System (MASS), to help them in making assignment decisions. The objective of this thesis is to develop a conceptual model of the data needed to support the system, transform the model into a relational schema and implement the design into an appropriate database management system (DBMS). Two data models are developed for this thesis. The first is an ideal, normalized model, and the second is a practical, denormalized one developed to facilitate the downloading of data from existing legacy mainframe systems to a PC-based system. Microsoft's Access DBMS software is used for the implementation of the MASS prototype. A rapid prototyping approach is used in developing the system. This approach was beneficial in encouraging active user participation and, through its iterative nature, was helpful in identifying the users' actual requirements. Significant lessons are learned from developing the prototype that will be helpful when implementing the production version.

A COMPARISON OF HIGH-END VIDEO TELECONFERENCE ALTERNATIVES FOR THE DEPARTMENT OF DEFENSE

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This thesis examines alternatives for conducting video teleconferences (VTC) within the Department of Defense (DOD). The three major areas examined include the Defense Commercial Telecommunications Network (DCTN), Federal Telecommunications System 2000 (FTS2000), and satellite VTC. All three alternatives are examined to identify discriminating features, including differentiating by cost components where possible. The thesis provides a basic introduction to VTC, including an explanation of VTC terminology and a discussion of VTC standards. The thesis looks at VTC within DOD, including some history, current applications and directives in effect. Several prominent DOD VTC networks are described. This research finds that each VTC method examined contains advantages that support its continued existence in the near-term. This thesis concludes that the variety of DOD applications justifies the divergent methods for employing VTC, until a DOD-wide standard communications infrastructure is in place.

CONVERSION AND MAINTENANCE OF CO-OP FOR WINDOWS

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The purpose of this thesis is fourfold: (1) conduct a review of CO-OP to include its background and the multiple criteria decision making algorithms and group aggregation techniques implemented in the existing version of CO-OP; (2) expand the model base to include ELECTRE 3; (3) expand the group decision module to include the Minimum-Variance technique and a revised version of the Min-Max technique; and (4) migrate CO-OP, using Visual Basic 2.0, onto a graphical user interface (GUI) environment that can be run with Microsoft Windows for Workgroup.

REENGINEERING THE DEPARTMENT OF DEFENSE: THE CORPORATE INFORMATION MANAGEMENT INITIATIVE

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In order to operate effectively in the 1990s and beyond, the DoD must improve its management and business processes. To accomplish this, the DoD has just released it "Corporate Information Management (CIM) Strategic Plan for the 21st Century." A number of independent studies, relating to CIM, have also recently been completed. This paper compares and evaluates the CIM Strategic Plan, the independent studies, and recognized methodologies of reengineering large organizations. It addresses shortcomings of the CIM Strategic Plan and recommends modifications and additions. Notable among these recommendations is the need to gain support for the Strategic Plan at all levels of the DoD. Additional measures, such as establishing a National Military Advisory Council, will help institutionalize the plan at the DoD and ensure its effective implementation. Finally, this paper concludes reengineering the DoD in accordance with a modified CIM Strategic Plan is feasible.

INFORMATION NEEDS ASSESSMENT OF THE PATUXENT RIVER NAVAL HOSPITAL

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The Patuxent River Naval Hospital is examining methods to provide the highest quality and access to care at the lowest cost possible. To do this, a number of data or information needs must be identified. It is the purpose of this thesis to identify Patuxent River Naval Hospital's information needs. A research method is applied to capture these information needs. Interviews with key managers reveal a number of Critical Success Factors (CSF). These CSFs are: Access to Quality Care and Service, Management of Financial Resources, Management of Physical Resources, and Management of Human Resources. Under each CSF, a number of functional needs are identified, with each being tied to a number of effectiveness measures. From these effectiveness measures, the information needs of the organization emerge. The identified information needs are examined against the existing information systems capabilities. A frame work is developed for examining the information needs of the Patuxent River Naval Hospital. Many of the identified information needs do not exist in the current information systems and recommendations are provided on how to fill the gaps.

A DESIGN RATIONALE CAPTURE USING REMAP/MM

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Every year the Department of Defense (DoD) spends between 24 and 32 billion dollars on software alone, with maintenance costs comprising the majority of this figure. Recent studies have indicated that an effective solution to help curtail development and maintenance costs is to capture the rationale behind systems requirements and designs, and use this information throughout the life cycle. This thesis explores the use of REMAP/MM and multimedia based design rationale management systems. Based on a case study, a detailed example illustrating to use REMAP/MM in various systems development activities is presented.

AN INFORMATION ARCHITECTURE FOR THE NAVAL POSTGRADUATE SCHOOL ENTERPRISE

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The advent of personal computers, workstations, and multiple interconnected Local Area Networks at the Naval Postgraduate School (NPS), Monterey, California, has resulted in significant distribution, redundancy, and fragmentation of the data elements and databases necessary to effectively manage the organization. This thesis addresses this issue by accomplishing the following two goals. First, it develops a high-level model of the organization's information architecture through the use of the Information Engineering methodology, with automated support the Texas Instruments' Integrated Computer Aided Software Engineering (I-CASE) tool Information Engineering Facility™ (IEF™). Based on the high-level model it then provides an analysis of data management architecture alternatives to address the current problems. The thesis main recommendation is for the implementation of a client/server information processing architecture at NPS. The enterprise and information architecture analyses provide additional recommendations to improve the current NPS organizational structure.

PROTOTYPE: AN EXPERT DATABASE SYSTEM OF ABRI (EDSA) TO ASSIST PERSONNEL SELECTION IN THE ARMED FORCES OF THE REPUBLIC OF INDONESIA

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Indonesian Armed Forces Academy, 1976
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An assignment of an officer of the Armed Forces of the Republic of Indonesia (ABRI) to a non-Department of Defense and Security (DEPHANKAM) position is considered just a tour of duty like any other assignment. One type of such assignment is appointment to become a member of a legislative body, especially the House of People's Representative (DPR). There are three types of DPRs, each requiring certain qualifications in order for an officer to be selected. The process of assigning the officers outside of DEPHANKAM is currently done manually and takes a great deal of time. This paper describes the design and implementation of a prototype expert database system that will substitute the laborious manual work in selecting the right officers to be assigned to a DPR position. The prototype design is based on a rule-based expert system and a personnel database of officers of ABRI. It produces a list of officers that match certain qualifications, along with the reasoning used by the system.

AN INVESTIGATION INTO THE LONG-TERM IMPACT OF THE CALIBRATION OF SOFTWARE ESTIMATION MODELS USING RAW HISTORICAL DATA

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The benefit of software cost estimation is universally recognized as one of the cornerstones of effective software project management and control. Despite the advances of computer-based estimation tools, their accuracy remains largely inadequate, and their utility among software development practitioners is limited. Consequently, the optimal estimation of software cost remains an elusive goal of most project managers. Central to this issue is the nature of the data on completed software projects that are incorporated into the organization's database of historical project results. This information forms the basis for both future project estimation and ex-post-facto assessment of estimation models. Actual project results are typically the data of choice for both the calibration and evaluation processes, despite the fact that these raw values disregard project inefficiencies such as initial size underestimation. This thesis challenges the notion that historical project results represent the preferred and most reliable benchmarks for future estimation purposes. Computer-based simulation is used to test a proposed strategy which capitalizes on an organization's learning experiences by neutralizing the cost excess caused by the initial undersizing, and that derives a posterior set of *normalized* effort and schedule estimation benchmarks. Analysis of the results indicates that normalization of the data leads to significantly improved project productivity, more optimal cost estimates, and provides the organization with increased potential for future cost savings.

DEVELOPMENT OF A STRUCTURED DESIGN AND PROGRAMMING METHODOLOGY FOR EXPERT SYSTEM SHELLS UTILIZING A VISUAL PROGRAMMING LANGUAGE; APPLICATION OF STRUCTURED METHODOLOGY TO THE MK92 MAINTENANCE ADVISOR EXPERT SYSTEM, PERFORMANCE MODULE PROTOTYPE

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This thesis is a part of a continuing effort to design and implement a diagnostic expert system for the MK92 Mode 2 Fire Control System (FCS) undertaken by the Naval Postgraduate School (NPS) faculty and graduate students. The focus of this thesis is the development of a structured methodology for the design and implementation of an expert system in an expert system shell utilizing a visual programming language. Guidelines for the application of the structured methodology in the Adept expert system shell were developed and applied to the initial Performance module of the MK92 MOD 2 FCS Maintenance Advisor Expert System prototype developed in an earlier effort.

KNOWLEDGE DISCOVERY USING GENETIC PROGRAMMING

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Dramatic growth in database technology has outpaced the ability to analyze the information stored in databases for new knowledge and has created an increasing potential for the loss of undiscovered knowledge. This potential gains for such knowledge discovery are particularly large in the Department of Defense where millions of transactions, from maintenance to medical information, are recorded yearly. Due to the limitations of traditional knowledge discovery methods in analyzing this data, there is a growing need to utilize new knowledge discovery methods to glean knowledge from vast databases. This research compares a new knowledge discovery approach using a genetic program (GP) developed at the Naval Postgraduate School that produces data associations expressed as IF X THEN Y rules. In determining validity of the GP approach, the program is compared to traditional statistical and inductive methods of knowledge discovery. Results of this comparison indicate the viability of using a GP approach in knowledge discovery by three findings. First, the GP discovered interesting patterns from the data set. Second, the GP discovered new relationships not uncovered by the traditional methods. Third, the GP demonstrated a greater ability to focus the knowledge discovery search towards particular relationships, such as producing exact or general rules.

FUNCTIONAL PROCESS IMPROVEMENT: THE DEPARTMENT OF DEFENSE REENGINEERING METHODOLOGY

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This thesis reviews the Functional Process Improvement methodology developed by the Department of Defense. Use of Functional Process Improvement, and its related tool set, provides the Corporate Information Management (CIM) initiative with a means of implementing business process improvements through functional technical, and economic analysis of alternatives. Review of this methodology consists of analyzing Department of Defense and Department of the Navy implementation guidance. Additionally, specific case study examples are explored and utilized. The analysis identifies the methodology's limitations and its' strengths. Included is a discussion of the Department of Defense's efforts to limit the impact of the perceived weaknesses, and exploit the methodology's inherent strengths.

A FRAMEWORK FOR EVALUATING APPLICATION OF SMART CARDS AND RELATED TECHNOLOGY WITHIN THE DEPARTMENT OF DEFENSE

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The author presents a new framework for evaluating the evolutionary upgrade paths of card technologies. Many functions which are now either not being done, or are being done manually, could be automated using card technologies. There is a revolution underway in card technologies, making them viable solutions to an expanding set of problems. The author examines these card technology initiatives, the shrinking defense budget, card selection issues, card authentication techniques, and evolutionary acquisition. Conclusions stress that card technology systems can be viewed as evolutionary upgrade paths that change over time. Simple cost benefit analysis does not capture the evolving nature of advancing technology. Effective evaluations of evolutionary card systems must consider this temporal component, and a framework, such as the one presented in this thesis, is needed for comparing alternative card systems.

DESIGN OF A COMPUTER NETWORK TO IMPROVE INFORMATION QUALITY FOR THE INDONESIAN ARMY

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B.S., Indonesian Armed Forces Academy, 1973
Master of Science in Information Technology Management-September 1994
Advisor: Myung W. Suh-Department of Systems Management

The Indonesian Army has used computers to gather information for over 20 years. Computers have been installed throughout the entire Army organization, from Army Headquarters down to Army Main Region Commands and Army Branches. Data is currently collected from various Army units in remote areas, recorded by the Army Main Region Commands and Army Branches, and then sent to the Army Headquarters all via courier service. To improve the quality of Army's command and control and administration processes, the data must be accurate and timely. Therefore, instead of sending the data manually via courier service, the data could be sent via electronic communication. This thesis analyzes the data collection process and recommends that the Army's computers be integrated via LANs at each major command and that long-haul connectivity be established via satellites in a star topology. The Department of Defense Communication Agency can provide Very Small Aperture Terminal (VSAT) service in single hope mode, and PT Lintasarta, a specialized data communication company, can provide data communication via Public Switched Packet Data Network (PSPDN) as a backup.

A COMPARISON OF THE JOINT MARITIME COMMAND INFORMATION SYSTEM (JMCIS) CAPABILITIES WITH THE UNITED STATES MARINE CORPS (USMC) ADVANCED TACTICAL AIR COMMAND CENTER (ATACC) DATA LINK REQUIREMENTS

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This thesis is a comparison of the capabilities currently available in the Joint Maritime Command Information System (JMCIS) to the data link requirements of the United States Marine Corps (USMC) Advanced Tactical Air Command Center (ATACC). The evolution of JMCIS and its underlying software design philosophy is discussed as well as the operational and financial advantages of this philosophy. The comparison of the ATACC requirements and the JMCIS capabilities is done using the Simple Multi-Attribute Rating Technique (SMART). The SMART technique assigns weight values to the ATACC requirements and calculates an overall comparison figure for JMCIS. The weight values were calculated from survey data. Survey subjects provided their perception to the relative mission criticality of the ATACC requirements. The subjects for the evaluation were U.S. Marine Corps Officers with air command and control experience, and the evaluations were elicited using the Criterion DecisionPlus™ software package. The comparison figure for JMCIS averaged across the survey subjects was 68%. The weighting factors and the model of the requirements revealed the shortfalls of the JMICS system in the area of data link maintenance functionality.

DESIGN AND IMPLEMENTATION OF A PROTOTYPE DATABASE FOR PART INFORMATION TO SUPPORT THE MK92 FIRE CONTROL SYSTEM MAINTENANCE ADVISOR EXPERT SYSTEM

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The MK92 Fire Control System (FCS) is the heart of shipboard weapon systems found aboard U.S. Oliver Hazard Perry class FFGs. This system, based on 1970's technology, frequently requires extensive troubleshooting and supplemental shore-base support. A maintenance advisor expert system is being developed to assist shipboard technicians in correctly diagnosing system faults, providing expert advice concerning part placement or further test which should be made. Additional information provided by the expert system includes documentation references, alternate location for a part, and part numbers. Storing such information in a relational database that communicates with the expert system would greatly improve its maintainability, modifiability, and accuracy. This thesis addresses the design and implementation of a database to support the MK92 MOD 2 FCS Maintenance Advisor Expert System using Microsoft Access™. This database includes such functions as part and replacement information, database maintenance, and expert system support. Research revealed that currently support Windows interprogram communications mechanism of Dynamic Data Exchange (DDE), as support by the current versions of Access and Softsell Adept™, will not adequately support the database to expert system interface requirements. Suggestions for alternative interface solutions are provided in the thesis.

LESSONS LEARNED FROM THE 14-YEAR SYSTEMS DEVELOPMENT OF THE MARINE CORPS' STANDARD ACCOUNTING, BUDGETING AND REPORTING SYSTEM (SABRS)

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In August of 1978 the Marine Corps initiated development of a consolidated financial management system. On October 1, 1992, after 14 years of systems development effort, the Standard Accounting, Budgeting and Reporting System (SABRS) was finally implemented throughout the Marine Corps. This thesis chronicles the 14-year SABRS systems development effort using the historical case study research method. Data is presented from both archival sources and personal interviews. The SABRS project reveals some important general lessons about the systems development process that will prove useful to future project managers tasked with developing large-scale administrative information systems. These lessons learned include, but are not limited to, (1) the importance of top management support, (2) the role of the project manager as leader, rather than technical expert, (3) the use of adaptive prototyping, (4) the importance of fitting the right people to the right task, and (5) the ability of management to alter its commitment to a failed course of action.

INDUSTRY VERSUS DOD: A COMPARATIVE STUDY OF SOFTWARE REUSE

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and
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Software reused is a longtime practiced method. The technical issues, such as how to link software repositories and programming for reuse, have been resolved. The problems faced by industry and the Department of Defense are of a non-technical nature and can be categorized into three broad categories: managerial, economic, and legal. This thesis compares industry and DoD reuse efforts highlighting common problems and lessons learned. The comparison is between IBM, Hewlett-Packard, the Air Force's Central Archive for Reusable Defense Software (CARDS), and the Restructured Naval Tactical Data System (RNTDS). Each reuse effort is studied using personal interviews and written descriptions. Problems encountered by private industry and their solutions are analyzed and compared to DoD. Many of the industry's problems are found to be prevalent in DoD. Industry recognizes these issues and is taking steps to rectify them. Legal issues are the least understood by industry and DoD, and need further research to overcome these hurdles. Some economic and managerial issues are recognized by DoD and are in process of being resolved. Industry is more advanced than DoD in their programs and understanding of reuse. DoD can alleviate some of its software reuse problems by employing the lessons learned from industry.

DESIGN AND IMPLEMENTATION OF A DATABASE MANAGEMENT SYSTEM TO SUPPORT ADMINISTRATIVE ACTIVITIES ONBOARD HELLENIC NAVY VESSELS

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The Hellenic Navy ships have a challenging mission which encompasses tactical, operational and administrative tasks. This mission is carried out by the personnel serving onboard. In order to more effectively manage the personnel, an automated database management system is required. This system would contain all personnel records and other pertinent information. Furthermore, the system would produce periodic reports required by other commands concerning crewmembers, as well as a variety of other reports designed by the user to support the daily activities onboard. This thesis designs and implements an automated database system that can be used on the Hellenic navy ships. The methodology followed is the standard systems' development life cycle (SDLC). The requirements for the system are obtained, and the database and application are designed and implemented. Paradox is used for the database management system software. Special issues like training, security, conversion and maintenance are taken into consideration. The result of this thesis is a functional application named "SPAS" (Shipboard Personnel Administration System) that will fulfill the users' requirements, keep track of the administrative activities of the ships, and help in performing the desired tasks accurately.

THE VERIFICATION AND VALIDATION OF THE MK 92 MOD 2 FIRE CONTROL SYSTEM MAINTENANCE ADVISOR EXPERT SYSTEM

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Verification and validation is the common name for a quality assurance process that is used in the development of software. The goal of verification and validation is to ensure that the developed software is complete and correct. It has been shown that the cost to correct software errors is orders of magnitude higher at the end of the development. This thesis describes the process for verifying and validating the MK 92 MOF 2 Fire Control System (FCS) Maintenance Advisor Expert System (MAES). A literature review was performed to assimilate the background knowledge with which to develop a framework for conducting the verification and validation. The framework is a general guide which could be used in the verification and validation process for DoD expert systems developed in a like environment, i.e., using an expert tool with similar knowledge representation schemes. Using the framework, a specific verification and validation plan was developed

INDUSTRY VERSUS DOD: A COMPARATIVE STUDY OF SOFTWARE REUSE

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Software reused is a longtime practiced method. The technical issues, such as how to link software repositories and programming for reuse, have been resolved. The problems faced by industry and the Department of Defense are of a non-technical nature and can be categorized into three broad categories: managerial, economic, and legal. This thesis compares industry and DoD reuse efforts highlighting common problems and lessons learned. The comparison is between IBM, Hewlett-Packard, the Air Force's Central Archive for Reusable Defense Software (CARDS), and the Restructured Naval Tactical Data System (RNTDS). Each reuse effort is studied using personal interviews and written descriptions. Problems encountered by private industry and their solutions are analyzed and compared to DoD. Many of the industry's problems are found to be prevalent in DoD. Industry recognizes these issues and is taking steps to rectify them. Legal issues are the least understood by industry and DoD, and need further research to overcome these hurdles. Some economic and managerial issues are recognized by DoD and are in process of being resolved. Industry is more advanced than DoD in their programs and understanding of reuse. DoD can alleviate some of its software reuse problems by employing the lessons learned from industry.

DESIGN AND IMPLEMENTATION OF A PROTOTYPE MONITOR ASSIGNMENT SUPPORT SYSTEM (MASS)

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A primary mission for the Manpower Management Officer Assignment (MMOA) Branch of Headquarters, United States Marine Corps (HQMC) is the placement of trained and qualified officers into authorized billets both internal and external to the Marine Corps. In accomplishing their mission, the monitors and their support staff rely on a variety of information sources to assist them in their decision making. Access to this information, however, is neither quick nor easy and too much reliance is placed on paper reports and microfiche, which are often outdated. To remedy this situation, this thesis develops a prototype PC-based Monitor Assignment Support System (MASS) to assist monitors in their day to day activities. The focus of this thesis is on the development of the assignment process model and its implementation into a database application. The prototype downloads updated personal and performance information about an officer which is used by a Marine monitor to make assignment decisions. MASS was developed using Microsoft Access database management system which proved to be a powerful and easy to use tool for developing this prototype.

KNOWLEDGE QUALITY FUNCTIONS FOR RULE DISCOVERY

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The Department of Defense (DoD) possesses tremendous amounts of data stored in many large databases. Due to the size of these databases, humans are incapable of efficiently discovering interesting and useful patterns so an automated data-mining tool is necessary. Output in the form of production rules, i.e., "If y Then x," is preferred because they are understandable by humans and support decision making processes. This thesis investigates the manner in which data-mining systems discover useful, interesting, but currently unavailable knowledge. The search and evaluation process, guided by a knowledge quality function, is the key task of a data-mining system. This thesis evaluates three knowledge quality functions taken from the literature. Each knowledge quality function discovers new and interesting sets of rules reflecting different characteristics of knowledge. DoD applications are suggested for each of the knowledge quality functions.

INTERPRETIVE ANALYSIS OF THE JOINT MARITIME COMMAND INFORMATION SYSTEM (JMCIS) SENSITIVE COMPARTMENTED INFORMATION (SCI) LOCAL AREA NETWORK (LAN) SECURITY REQUIREMENTS

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The primary purpose of this thesis is to provide an analysis for each of the specific security requirements established for the Joint Maritime Command Information System (JMCIS) Sensitive Compartmented Information (SCI) local area network. The development of JMCIS and its importance within the interoperability arena of Department of Defense (DoD) Command, Control, Communications, Computers, and Intelligence (C41) systems is discussed. A description of the components for the SCI local area network and supporting computer security principles is presented. The author employs the criteria established in the Trusted Computer System Evaluation Criteria (TCSEC) and other authoritative sources to evaluate and interpret the security requirements under the broad category of *Technical (Computer) Security Requirements* for the JMCIS SCI local area network. The results of the analysis support the JMCIS SCI local area network developer's selected scurity requirements.

COMPARITIVE ANALYSIS OF TECHNIQUES FOR CLASSIFICATION WITH RESPECT TO RULE INTERESTINGNESS

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The potential gains from an effective mechanism for discovering interesting patterns or rules from large databases are particularly large in the Department of Defense where millions of transactions are recorded yearly. The need to develop and evaluate new knowledge discovery techniques useful in extracting interesting patterns in vast databases is gaining considerable attention. This research compares two classification techniques; one based on traditional decision-tree algorithms, and another based on genetic programming which derives its behavior from a metaphor of the processes of evolution in nature. A methodology for comparing rules generated by the two systems with respect to rule performance, simplicity, significance, and redundancy is presented and illustrated in detail. The analysis of results indicate that the genetic programming approach outperforms the decision-tree inductive system and produces a greater number of interesting rules.

ANALYSIS OF THE NAVAL POSTGRADUATE SCHOOL COMPUTER NETWORK ARCHITECTURE

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The computer network on the Naval Postgraduate School campus has become an integral part of the operations of the Naval Postgraduate School organization. An analysis of the network architecture will help formulate strategic plans that will support the network and the Naval Postgraduate School to the end of the century. This study describes the Naval Postgraduate School computer network architecture, driving forces, limitations, and possible measures of network benefits. It considers network alternatives and reasonable transition strategies. The study offers recommendations for improvements to the existing network configuration.

DRUGDOG 3.0 US NAVY RANDOM URINALYSIS SOFTWARE PACKAGE

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Although the United States Navy has had a mandatory Random Urinalysis Program in effect for many years, there has never been a formal, standardize methodology to implement the process. OPNAV INSTRUCTION 5350.4 (series) provides guidance on what must be accomplished, but not how to accomplish it. Automation and standardization of the program through software implementation can lend confidence to personnel who are subject to the program that it is fairly and uniformly applied to each member of the command. Information attempts at developing Random Urinalysis software utilizing unstructured methods has had less than successful results. To address this problem, this thesis describes the development of a complete software application designed to automate the Random Urinalysis Program. Using previous versions of urinalysis software as templates, a standardized, structured approach to application development is used to create a new software system. The Definition, Requirements, Evaluation, Design and Implementation phases of software development life-cycle are fully utilized during project development. The result is an actual working tool for the fleet. DRUGDOG 3.0 is a comprehensive software application that will aid individual Urinalysis Coordinators in implementing the Navy's Random Urinalysis Program within their command.

MASTER OF SCIENCE
IN
INTERNATIONAL RESOURCE
PLANNING MANAGEMENT

A CLOSE LOOK TO THE FUTURE OF TURKISH-IRANIAN RELATIONS

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The purpose of this thesis is to examine relations of Turkey and Iran under the perspective of their cultural biases and security prerequisites. It is important to evaluate both countries and their foreign policies, which face many challenges after the post cold war era, in understanding possible futures of both countries. This thesis provides historical background of their relations and major current issues between the two countries. An analysis of factors shaping the decision-making process in Turkey and Iran gives the reader tools to speculate about their future relations. Several possible scenarios of conflict are developed and their probable outcomes examined. General results of this thesis reveal the necessity of cooperation between the two countries. Mutual understanding and cooperation will also have an impact on the stability and development of the region. The Economic Coooperation Organization may provide a mechanism for the two countries to improve their relations and increase stability.

APPROPRIATENESS AND APPLICABILITY OF THE USE OF PERFORMANCE INCENTIVES FOR WARSHIP PROCUREMENT

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The end of the cold war caused defense budgets to decrease in a sharp manner. This trends requires the Navy, as a branch of the DOD, to tighten its controls over spending and become more cost-effective. Since warship procurement is among the most important financial transactions of the Navy, one instrument that might improve the cost-effectiveness of the Navy is the use of cost and performance incentives in warship procurement. This thesis studies the traditional and current theories of incentive contracting. It explains the relationship between incentives and cost-effectiveness, and how the use of incentives can encourage contractors to put in a high level of effort on projects so that the government will benefit more. To define the performance level of a warship, analytical approaches, such as the use of an operations research model with the aid of response surface methodology, and the subjective figure of merit model are discussed. This thesis also presents some views on the principal-agent problem, and it expends the idea of using the contractor's unobservable effort level as means to determine what type of incentives to offer. To compare the traditional and current concepts of incentives, two specific examples are constructed and examined.

THE SPRATLY ISLANDS: A BREWING FLASHPOINT IN ASIA

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The Spratly Islands located at the heart of South China Sea in Asia is developing to be a flashpoint in the region. Geological surveys conducted underneath the seabed of these islands following the oil crisis in the 1970s shows an enormous potential of oil and gas reserves notwithstanding the existence of rich marine resources. Moreover, with the adoption of the new international Law of the Sea concept there are overlapping claims by contending countries. Unless these claimant countries-namely China, Vietnam, Taiwan, Malaysia, Brunei and the Philippines-reconcile their differences and come to terms the conflict is bound to escalate. This thesis is an in depth study of the disputes over the Spratlys and examines four cases of islands based territorial disputes that could be used as a model in resolving these tensions. Although there is an apparent build up of military capabilities by claimant countries in recent years, this thesis argues that a military option will only create divisions and strain longstanding animosities. Instead, a peaceful solution is recommended through a cooperative regime as quickly as possible so that contending countries will realize the full potentials of these islands.

KOREAN REUNIFICATION: THE IMPLICATIONS FOR REGIONAL SECURITY

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Korean reunification is one of the most critical issues of the post-Cold War era, not only for the Korean peninsula, but also for regional security. This study analyzes Korean reunification in the context of Northeast Asian and Northern Pacific regional security. A systemic framework is utilized as an analytical tool to examine the motivations of states with interests in the region. The study concludes that an incremental functional approach would be the most efficient and effective way to achieve Korean unification while simultaneously strengthening regional security. A stable process of unification would contribute not only to Korea's future, but also to regional and global peace, prosperity and democracy.

DRUG AND IMMIGRATION ISSUES IN THE MEXICO-US RELATIONSHIP

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Master of Science in International Resource Planning and Management-June 1994
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This thesis investigates the relationship between Mexico and the United States, specifically in terms of the impact of ongoing trends in drug smuggling and illegal immigration. The work begins with a review of the historical development process in each country, a discussion of the meaning of the border relationship, and the placement of drug trafficking and immigration issues within their current contexts. Following this introduction to the issues, drug trafficking and immigration are each explored in depth. The research effort concludes that economic motivations are at the root of problems stemming from the issues of drug trafficking and immigration, and that the traditional paradigms of the Mexico-US relationship, as well as a profusion of political finger-pointing, prohibit it from evolving into the partnership necessary for the continued development and prosperity of the two countries. Recommendations include acknowledging the historical and cultural differences at work in the countries, an admonition against US internal involvement in Mexico, and several more specific recommendations for dealing with the problems of drugs and immigration that were identified during the research.

AN APPRAISAL OF U.S. SECURITY ASSISTANCE TO TURKEY BETWEEN 1950 AND 1992

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This thesis analyzes U.S. security assistance to Turkey between 1950 and 1992. It describes historical trends in U.S.-Turkey arms transactions by examining statistical expenditure data on seven components of the U.S. security assistance program. The thesis identifies the impact of four key factors on U.S. arms sales to Turkey during this period. These factors are the Korean War, NATO, Greek-Turkish relations, and the Gulf War. Three different aspects of arms sales - military, political and economic - are taken into consideration. The roles played by Congress and the executive branch in influencing U.S. aid to Turkey are examined. The thesis concludes that the Korean War, NATO, and the Gulf War support closer military ties between Turkey and the United States, while disputes between Greece and Turkey tended to weaken it.

DEMOCRACY IN INDONESIA

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There is a wide-spread adherence to democracy as a form of government. Since the development of the concept, many countries have defined and practiced democracy after necessary modifications based on respective national interests and political culture. So did Indonesia after it gained independence from the Dutch colony. Soekarno was the first president of the country. He developed and practiced "parliamentary democracy" and later "guided democracy" which was based on state ideology and its political culture, and which addressed national interest. Since its introduction, pancasila democracy has been the system of government for the last 27 years. This thesis examines the development of democracy, its variations over time, and lastly different forms of democracy practiced in Indonesia with special emphasis on the prospects of pancasila democracy.

COMMUNIST INSURGENCY IN THE PHILIPPINES

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In the post Cold War and the collapse of communism in the Soviet Union and Eastern Europe, the communist insurgents in the Philippines are still a potent force and the main threat to the country's national security. The purpose of this thesis is to examine the issues that brought about the resurgence of the communist insurgency and the counterinsurgency measures undertaken by the government. Economic disparity and injustice are major reasons for people to take up arms against the government. Unless these are resolved the insurgency problem will continue to persist. A purely military solution to the problem will not solve the communist insurgency in the Philippines. While the CPP is the most potent threat to the security of the Republic of the Philippines, is not yet in a position to win militarily against the Armed Forces of the Philippines. In the same manner, the Armed Forces of the Philippines could not totally defeat the insurgents for as long as the basic issues that attract or draw the people to the communist movement are not addressed by the government.

ARAB MAGHREB UNION: ACHIEVEMENT AND PROSPECTS

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February 17, 1989, witnessed the signing of the Arab Maghreb Union (AMU) Treaty. This union has been a dream of many generations of the peoples of North Africa. It is a natural union, since history and the shared geographical location have shaped this region into a distinct entity. United the Maghreb region can better defend its interests, and increase its bargaining power in dealing with the other trading Blocks. The changing global World Order, and the emergence of many regional Blocks, motivated the North African countries to work on achieving the integration of the region in order to face the internal and external challenges, while at the same time contributing to promoting and safeguarding peace and stability around the region. Along with the thoughts on the reality of the North African countries, this project analyses the achievements and the prospects of the Maghreb integration.

MANPOWER PLANNING IN THE ZIMBABWE PUBLIC SECTOR: A MYTH OR REALITY?

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Almost all of the human resources management problems experienced in the Zimbabwean public sector today are related to the lack of qualified personnel. The expansion of government into "development" fields and the attendant growth in administration have increased the number of inexperienced personnel. Consequently, there is a clear need to make changes to develop a modern and efficient public sector. It presents various techniques that may be applied by decision makers for the effective utilization of human resources in the public sector. The intent is to provide a useful basis for change in the human resource management culture in the civil service of Zimbabwe. It is appropriate to focus on this important aspect of the personnel function now in view of current resturcturing occurring in the public sector of Zimbabwe.

UNITED NATIONS HUMAN AND FINANCIAL RESOURCES FOR PEACEKEEPING IN AFRICA (ANGOLA, LIBERIA, MOZAMBIQUE, RWANDA, SOMALIA, WESTERN SAHARA)

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The United Nations, as an international moral authority, will often be requested to intervene in Africa. The United Nations currently has six operations in the African continent (Western Sahara, Liberia, Angola, Rwanda, Somalia and Mozambique). Many African people feel that the United NATIONS should be involved in other parts of Africa, but the UN Human and Financial resources are not infinite. In other words, the United Nations cannot be in every troubled spot of Africa or be able to mobilize the required Human and Financial resources to bring peace and security to an African continent beset by tribal, ethnic, political, economical and social problems. The United Nations should choose and select the operations that have a likelihood of success. How should these operations be chosen? The United Nations may assess potential and ongoing peacekeeping operations through five necessary criteria for likelihood of success. These five criteria are discussed in this thesis. In addition, a model for assessment of these criteria is introduced. The six United Nations operations are assessed by this model, with a success ranking derived for each. This ranking may be used to select UN peacekeeping operations. The United Nations could then redirect its efforts if necessary. The premise of this thesis is to introduce a tool that may be used by the United Nations to assess its operations in Africa.

POLAND IN NATO? A CASE STUDY OF THE UNITED STATES FOREIGN POLICYMAKING PROCESS

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The opportunity for nations such as Poland to enter NATO is of vital concern for their security. Indeed, the problem of inclusion into the Western alliance is the key issue for the majority of former Warsaw Pack members. After the dissolution of the Soviet bloc, these countries are no longer members of a security alliance. Yet, with the end of the Cold War, Poland confronts significant new security risks -- making the need to join an alliance such as NATO all the more important. The United States plays a key role in determining whether Poland will be invited into NATO. What will guide that decision? What lessons can be learned about U.S. decisionmaking from the creation of the Partnership for Peace, and what are the implications for possible Polish entrance into NATO? This thesis is based on interviews with U.S. policymakers on NATO expansion. The history of that policy, especially the creation of the Partnership for Peace as an alternative to immediate alliance expansion, offers a case study for drawing broader conclusions about the U.S. policymaking process. This thesis outlines that history, and argues that bureaucratic politic theories of U.S. policymaking are inadequate to explain the issue of NATO expansion. With the end of the Cold War, and scrambling of previous institutional interests with the U.S. Government, those interests provide only limited help in accounting for the policymaking process that led to the Partnership for Peace. The fear of hostile Russian reaction to NATO expansion provides much of rationale for U.S. opposition to inviting nations such as Poland into the alliance. However, significant disagreements persist over this issue, both within and between key U.S. policymaking organizations. The fragmentation of power in the U.S. decisionmaking process -- and the attendant need for compromise between actors -- also played a decisive role in the genesis of Partnership for Peace. This same multiplicity of interests and fragmentation of power offers Poland the opportunity to press its case from a variety of useful perspectives.

THE FUTURE AND PROSPECT OF THE ASSOCIATION OF SOUTHEAST ASIAN NATIONS

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The Association of Southeast Asian Nations (ASEAN) has been in existence for more than 25 years. Its member nations, (Brunei, Indonesia, Malaysia, the Philippines, Singapore,, and Thailand) have emphasized the role of the association as a neutral organization based on co-operation among members in the spirit of equality and partnership that would bring mutual benefits and stimulate solidarity which can contribute to building the foundation of peace, stability, and prosperity in the ASEAN region in particular and the world in general. With the end of the Cold War and the collapse of the Soviet Union, this thesis will try to examine the relevance of the ASEAN's original intention in the formation of the organization. With the uncertainty of the US military presence in the region, Japan's growing military capabilities, China's continuous military modernization, and other developments in the region, is it necessary for the ASEAN to be transformed into a defense and security alliance? Is the ASEAN capable of forming a military defense pact? Finally, this thesis will examine the future and prospect of the ASEAN as a regional organization.

MASTER OF SCIENCE
IN
MECHANICAL ENGINEERING

A PRELIMINARY ATTEMPT AT SINTERING AN ULTRAFINE ALUMINA POWDER USING MICROWAVES

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A commercially available microwave oven was used to sinter ultrafine alumina powders (0.0200.05 um particle size) with and without CaO sintering aid. The oven was modified by inserting a thermocoule probe through the bottom housing, and thoroughly insulating the interior with insulating material. The oven was placed in a glove box and filled with argon to prevent degradation of the thermocouple, and oxidation of the powdered graphite susceptor. Heating rates of 50-75 Deg C/sec with a maximum temperature of 1575 Deg C were obtained. Limited success in sintering of the powder compacts weas achieved in this preliminary effort. The microstructures of the sintered products were examined by scanning electron microscopy. It was concluded that further work is necessary to develop this technique into one which can be used for the routine sintering of fine powdered ceramic material. A review of the literature on microwave sintering of ceramic powders is also reported.

FINITE ELEMENT MODELING OF PARTIALLY DELAMINATED COMPOSITE BEAMS WITH CONTACT-IMPACT CONDITIONS

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A new finite element modeling is presented to investigate the static and dynamic behavior of laminated composite beams with partial delamination. In this study, a newly developed rectangular beam element is used. The element has lateral and axial displacements as degrees of freedom but no rotation. For simplicity, linear shape functions are used for the beam element. As a result, the element has six degrees of freedom, four of which are the axial displacements at the corner points and two are the lateral displacements at the ends. In addition, contact-impact conditions are applied to the finite element modeling to avoid overlapping of the upper and lower portions of a delaminated section. The numerical study shows that depending on existence of an embedded delamination crack and its size, the response is different for a beam with a crack and subjected to a short impulse load.

THREE-DIMENSIONAL EFFECTS OF CRACK CLOSURE IN LAMINATED COMPOSITE PLATES SUBJECTED TO BENDING LOADS

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Fracture is one of the dominant failure modes in structures subjected to external loads. Stress and deformation fields around the crack tip are important to understand the crack propagation and arrest. For plate with a through-the-thickness crack and subjected to a bending load, there is crack closure on the compression side of the crack face. The present study investigates effects of crack closure on the stress and deformation fields on the tension side of the crack face. A three-dimensional finite element analysis is performed for laminated composite plates using both the line and surface crack closure models. For a composite whose longitudinal elastic modulus is much greater than the transverse modulus, line and surface closure models result in higher stresses near the crack tip in comparison to the no-closure solution. Hence, no-closure solutions are nonconservative for the composite. Transverse shear is the major cause for the nonconservative solution.

HOPF BIFURCATION ANALYSIS FOR DEPT CONTROL OF SUBMERSIBLE VEHICLES

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Control of a modern submarine is a multi-dimensional problem coupling initial stability, hydrodynamic and control system response. The loss of stability at moderate to high speeds is examined using a nonlinear Hopf bifurcation analysis. Complete linear state feedback is used for demonstration purposed for depth control at level attitude and for a fixed nominal speed. Control time constant, nominal and actual speeds, metacentric height, and stern to bow plane ration are used as the main bifurcation parameters. A complete local bifurcation mapping provides a systematic method for evaluating the bounds of controllability for control system design parameters for a submarine with a given set of hydrodynamic coefficients. The submarine and its potential design modifications are then verified with a nonlinear simulation program.

CHARACTERIZATION OF ULTRA-LOW CARBON BAINITIC STEELS FOR USE AS WELD WIRE CONSUMABLES

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The use of Ultra-Low Carbon Bainitic (ULCB) steels for weld wire applications is an area of current interest to the U.S. Navy and is being jointly studies by the Naval Postgraduate School, and the Naval Surface Warfare Center, Annapolis, MD. The focus of the present work is to determine the effect of macrostructure, microstructure, and the size, distribution and chemical composition of the non-metallic inclusions on the strength and impact toughness of multipass Gas Metal Arc (GMC) and Gas Tungsten Arc (GTA) welds. Eight sample multipass GMA and GTA weldments using ULCG weld wire were studies by optical, scanning electron and transmission electron microscopy (SEM and TEM). The microstructues of the weld metals were dominantly bainitic except for the recrystallized regions of the GTA welds which had become ferritic. The macrostructure of the GMA weldments was dominated by columnar grains. SEM and optical fractography suggested that this macrostructure is responsible for the corresponding poor toughness in these weldments. In all weldments the non-metallic inclusions were found to be very samll (on average <0.5 microns) with a somewhat higher volume fraction in the GMA vice GTA weldments. Based on previous work, the small average size of these inclusions are surmised to have had very little effect on toughness.

FINITE ELEMENT ANALYSIS OF DAMAGE IN FIBROUS COMPOSITES USING A MICROMECHANICAL METHOD

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The objective of this investigation is to study the damage mechanics of composite structures using a micromechanical approach for determining strength and stiffness degradation of the composite structures as damages, such as matrix cracking and fiber breakage, progress. The micromechanical cell method provides for analysis of stress at the fiber and matrix level while providing smeared composite properties for global structural analysis. As a result, the damage and failure criteria are expressed in terms of the fiber and matrix stress level of the composite structure. A correlation for stiffness reduction due to transverse cracking of a ceramic matrix composite under tensile loading is implemented in a three-dimensional finite element model. Next, thermal residual stresses from fabrication of the ceramic matrix composite are incorporated into the analysis. Finally, the finite element method is applied to a polymer matrix composite laminate with a center hole in order to study the progression of damage and final failure during tensile loading. The comparisons between the present predictions and the experimental results for the previous examples are very good.

NATURAL CONVECTION COOLING OF A THREE-BY-THREE ARRAY OF LEADLESS CHIP CARRIER PACKAGES IN A DIELECTRIC LIQUID

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Mechanical Engineer-March 1994
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Liquid cooling of a three-by-three array of commercially available leadless chip carrier packages, mounted on a ceramic substrate was examined. Baseline data were obtained for cooling with pure dielectric liquids. The effects of addition of high thermal conductivity ceramic powder to the liquid were next examined, both for natural and forced circulation conditions. Vertical and horizontal orientations were studied, for two different ceramic particle types, and two different particle sizes for each ceramic. For a range of chip power levels, chip, substrate and cold plate temperatures were measured. Interpretations for these data are provided. A numerical model was developed for the vertical geometry and compared to the measurements obtained.

THE ORGIN OF ACICULAR FERRITE IN GAS METAL ARC AND SUBMERGED ARC WELDS

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The nature of weld metal inclusions in relation to the formation of acicular ferrite was investigated. Gas-metal arc welds (GMAW) on High Strength Low Alloy (HSLA) plate with varying amounts of oxygen and/or carbon dioxide added to the argon cover gas and submerged arc welds (SAW) on HY-100 plate with five different fluxes were analyzed. This analysis determined the effect of weld metal composition on non-metalic inclusion composition and the ultimate effects on the formation of acicular ferrite. Scanning and transmission electron microscopy with energy dispersive x-ray analysis were used to determine inclusion size distribution, concentration and composition. This investigation revealed that the inclusions were complex MnO-Al_2O_3-SiO_2-TiO_2 oxides which contain a titanium-rich compound, Pyrophanite ($MnTiO_3$), existing as a faceted particle in those inclusions promoting acicular ferrite formation. From these results and the research of others such as Grong/Matlock and Ramsay/Matlock/Olson it is concluded that the formation of acicular ferrite does depend on non-metallic inclusion composition demonstrating the importance of weld wire composition for achieving welds with optimum mechanical properties.

SUBMARINE MACHINERY CRADLE: STRUCTURAL DYNAMIC DESIGN AND ANALYSIS TECHNIQUES USING FREQUENCY DOMAIN STRUCTURAL SYNTHESIS

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The tactical implications of submarine acoustic radiation and UNDEX-survivability have motivated the development of an advanced machinery cradle which will provide shock and vibration isolation of the submarine internals, thereby minimizing the resulting acoustic radiation. The cradle space frame must be designed and optimized for both minimum shock/vibration bi-directional transmissibility and minimum total cradle weight. Frequency domain structural synthesis (structural modification and substructure coupling), is applied to the cradle design. The method addresses static and complex dynamic problems in structural design analysis, and allows the direct analytic treatment of specialized equipment, such as frequency-dependent visco-elastic isolators.

AN INITIAL ASSESSMENT OF FREE SURRFACE EFFECTS ON SUBMERGED BODIES

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This thesis presents a study of free surface effects on submerged bodies. The motivation for this study lies in the significance of free surface suction effects during submarine operations at periscope depth. Such operations become increasingly important as new roles for the Navy in littoral waters are emerging. Particular emphasis is placed on computation of steady state forces on the body as a function of speed, depth, and wave requency and direction. These forces constitute an important and very frequently limiting factor in establishing the periscope depth submerged operating envelope. Solution of the problem is accomplished by singularity distribution on the actual surface of the body and discretization in the form of plane quadrilateral elements. Parametric studies are conducted in order to assess the effects of body shape and size. The results of this thesis can be directly utilized in the simulation based design process as well as during training.

PARAMETRIC STUDIES OF THE DYNAMIC STABILITY OF SUBMERSIBLES

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This thesis analyzes the dynamic stability of submersible vehicles in motions in six degrees of freedom. A continuation algorithm is used in order to obtain the steady state solutions in terms of dive plane angle, rudder angle, and longitudinal separation of centers of gravity/buoyancy. The equations of motion are then linearized in the vicinity of the above stated nominal point. The eigenvalues of the linearized system indicate the degree of stability of the nominal motion. The results demonstrate the stabilizing or destabilizing effects of general three dimensional motions as opposed to the traditional use of straight line level flight paths. Recommendations for robust design of control laws of commanded paths in combined horizontal/vertical planes are provided.

IMPROVING DETECTION AND ACQUISITION IN JANUS(A) USING THE PEGASUS DATABASE

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Janus(A) is a wargaming simulation in which opposing army forces interact within a pre-specified terrain database. The smallest unit of area in the terrain is 100 meters by 100 meters. Work is described which utilizes a one meter by one meter terrain database, allowing existing detection and acquisition algorithms to become more dynamic and more realistic. Development of a line of sight algorithm used to incorporate the higher resolution database is discussed. The resulting algorithm is demonstrated in a simulation of a target moving through obstructions contained within a limited terrain described by the one meter database.

OPTIMAL CONTROL OF A TWO WHEELED MOBILE ROBOT

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Feedback control of a two wheeled mobile robot from one point in its configuration space to another presents a challenging problem. The mobile robot belongs to a class of systems with non-integrable motion constraints for which smooth feedback control laws cannot be designed. Recent work has been aimed at developing time-varying feedback control laws and piecewise smooth feedback control laws. These control techniques are, however, not optimal in any sense. In this research, we look into the optimal control of a mobile robot using partial feedback. A solution is obtained by application of Pontryagin's Minimization Principle and solving the associated two point boundary value problem using a numerical relaxation technique. The resulting robot trajectories exhibit optimal behavior for all non-trivial cases.

EXPERIMENTAL INVESTIGATION INTO THE DYNAMIC RESPONSE OF TWO DOF TUNED DECK SIMULATOR FOR SHOCK QUALIFICATION OF SHIPBOARD SYSTEMS

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The explosive shock created by the underwater explosion of a mine or torpedo in close proximity to a surface ship can severely threaten the combat capability and survivability of the ship. MIL-S-901D specifies the shock test procedures and acceptance criteria for all shipboard systems that must resist high impact mechanical shock. While the U.S. Navy's Mediumweight Shock Machine with its standard equipment mounting fixture can subject a combat systems component to more sever shock excitations than experienced in actual ship shock trials, it cannot simulate the lower frequency excitations typically transmitted through a ship's superstructure during shock trials that expose equipment to catastrophic resonant vibration. This study is an experimental investigation into the dynamic response of the recently build Two Degree-of-Freedom (2DOF) Tuned Deck Simulator (TDS) for the Mediumweight Shock Machine (MWSM) to evaluate its potential role in the pre-acceptance shock qualification of new shipboard combat systems equipment. Upon completion of final characterization testing, the 2DOF-TDS could be integrated into the mediumweight shock qualification procedures of MIL-S-901D. This improvement could significantly enhance the capacity of a warship to absorb damage and still maintain its mission integrity.

DAMAGE AND COMPRESSIVE FAILURE OF UNBALANCED SANDWICH COMPOSITE PANELS SUBJECT TO LOW-VELOCITY IMPACT

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An unbalanced sandwich composite structure consisting of titanium and glass reinforced plastic (GRP) facesheets with a phenolic honeycomb core will be used for construction of a surface ship mast. Principle areas of concern in using these composites in primary load-bearing applications are the response due to compressive loads and the effects of low-velocity damage. This research focuses on experimental studies of the compressive strength after impact (CAI) of unbalanced sandwich composite beams. The beams, in simply supported configurations, are impacted transversely and then subjected to compressive axial loads. Samples are impacted on both the titanium and GRP sides. Additionally, the composites are statically loaded on each side. This study investigates initiation and progress of damage in the unbalanced sandwich composite beams caused by various impact loads. In addition, effects on the compressive failure load resulting from the various impact loadings are examined.

EROSION EFFECTS ON THRUST VECTOR CONTROL VANE HEAT TRANSFER CHARACTERISTICS

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This work describes the effects of erosion on the heat transfer characteristics on thrust vector control vanes exposed to aluminized propellant exhaust flows. This was accomplished using an inverse heat transfer parameter identification of quarter scale models. The model is based on a four node lumped parameter system with two heat energy inputs. The ablation is modeled as decreasing the geometric dimensions linearly as a function of time and percent mass loss. Excellent agreement was found between experimental and model temperature profiles. The heat transfer coefficients of the vanes were found to decrease with increasing erosion rates.

EXPERIMENTAL STUDY OF SPATIALLY INCOMPLETE STRUCTURAL SYSTEM IDENTIFICATION

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A frequency domain transformation is the basis for a general approach to the identification of finite element modeling errors. The transformation provides information as to the location of modeling errors and provides the error matrices of stiffness, mass, and damping. The transformation is shown to have the unique property of directly revealing that the process of instrumenting an actual structure with a finite number of response transducers defines a reduced order system, with an attendant set of singular frequencies responsible for the nonlinear distortion imposed on the corrective parameters of stiffness, mass, and damping. Actual test data demonstrating this phenomenon will be presented.

STUDY OF DAMAGE EVOLUTIONS IN COMPOSITE PLATES SUBJECTED TO BENDING LOADS USING MICRO-MACRO ANALYSIS

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The purpose of this study is to develop a computer program that will predict the damage progression in composite plates subjected to bending loads. Kwon's micromechanical model is used to compute the smeared effective moduli from the material properties of fiber and matrix as well as to determine stresses at the constituent level. Failure criteria based on micro-stresses are then applied to determine the extent and type of damage that occur in the composite under various loading conditions. The progression of damage throughout the composite until complete failure of the composite can then be simulated using the current computer program. The numerical prediction for a laminated composite plate containing a hole and subjected to a bending load agrees well with the experimental data.

TIME-FREQUENCY DOMAIN DISTRIBUTION AND ITS APPLICATION TO RECIPROCATING MACHINERY ANALYSIS

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Accurate assessment of shipboard machinery condition is essential in increasing the operational capability of naval vessels. Current shipboard machinery vibration monitoring and diagnostic procedures use frequency domain spectra to identify possible faults and problem areas. This method has proven to be inadequate for receiprocating machinery analysis. In reciprocating machinery the vibration signal is no longer a stationary, ergodic process, but is time-dependent and in some cases transient. This study proposes the use of Pseudo Wigner-Ville Distribution and introduces Wavelet Analysis as two advanced methods for condition monitoring of non-stationary and transient shipboard machinery. These methods employ a time-frequency domain distribution for the detection of fault location and severity level. To demonstrate the benefits of a time-frequency representation, vibration data from two types of reciprocating air compressors will be processed for analysis. To simulate faulty conditions, constructed artificial fault signals will be introduced into the vibration data and analyzed. It is proposed that Wavelet Analysis will play a complementary role to the Pseudo Wigner-Ville Distribution technique.

SPECTRAL ANALYSIS OF VORTEX/FREE-SURFACE INTERACTION

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The unsteady flow of phenomena resulting from the interaction of vorticity with a free surface has been investigated through the use of a three-color Laser-Doppler-Velocimeter. The vorticity field was provided by a single tip vortex generated by an airfoil, placed in the test section of a recirculating water tunnel at a suitable angle of attack. All of the statistical quantities of flow such as turbulence and Reynolds stresses and in particular the spectrum of the fluctuations have been measured and analyzed. The results have shown that the free surface redistributes part or all of the normal turbulent kinetic energy into streamwise and spanwise components. Furthermore, the energy spectra have also shown that there exists an energy gradient on the free surface, on either side of the vertical passing through the original vortex. It is believed that the scars observed on the free surface are a consequence of the matching of the Bragg wave length with the wave length of the surface signatures within a particular spectrum.

EFFECT OF INITIAL IMPERFECTIONS ON THE RESPONSE OF CYLINDERS TO UNDERWATER EXPLOSION

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Mechanical Engineer-December 1993
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Presently, the United States Navy is searching for an improved method to predict the damage to ship hull or underwater structure that results from an underwater explosion. One method of predicting this damage is through the use of nonlinear finite and boundary element analysis. Underwater Shock Analysis (USA) code combined with VEC/DYNA3D code is used for the analysis of the effect of explosive shock on numerical models. Initial geometric imperfections are introduced in the numerical model using model imperfections. The resulting numerical model is then subjected to a simulated underwater shock using the combined USA/DYNA3D code. A sensitivity analysis is performed to look into the details on the damage resulting from these simulations.

THE EFFECT OF THERMOMECHANICAL PROCESSING ON MECHANICAL PROPERTIES OF A CAST 6061 ALUMINUM METAL MATRIX COMPOSITE

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Thermomechanical processing was conducted on cast 6061 Al-Al_2O_3 metal matrix composites (MMCs) containing either 10 or 20 volume percent of alumina (Al_2O_3) particles. These materials were provided by DURALCAN-USA, Inc., of San Diego, CA in conjunction with a Cooperative Research and Development Agreement (CRDA) program on ductility enhancement for these MMCs. Processing included isothermal forging and rolling of materials at 500° C, with interpass anneal (IPA) times of 5 or 30 minutes. Isothermal rolling was also accomplished on 1.0 inch thick 6061-T6 Al plate. Processed materials were solution heat treated at temperatures ranging from 480-560° C, and were then age hardened at 160° C. Tensile testing was conducted to evaluate strength and ductility. Homogeneity of the particle distribution was improved by processing for both composites and no microstructural damage was apparent. Lower solution heat treatment temperature provided significant ductility enhancement while the longer IPA time at 500° C had a minor beneficial effect. As the percentage of reinforcement increased, aging time to peak strength decreased; peak strength, and yield strength increased; and ductility decreased. As the solution heat treatment temperature was decreased ductility was enhanced at a cost of peak strength.

A TRANSMISSION ELECTRON MICROSCOPE CHARACTERIZATION OF SODIUM SULFATE HOT CORROSION OF SILICON CARBIDE FIBER-REINFORCED LITHIUM ALUMINOSILICATE GLASS-CERAMIC MATRIX COMPOSITE

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Sodium Sulfate hot corrosion of a SiC/LAS composite was studied using conventional transmission electron microscopy and selected area diffraction. Changes in the morphology, composition and crystallography of the phases in the glass-ceramic matrix and the fiber/matrix interface were studies. Microchemical analysis using energy dispersive x-ray spectroscopy (EDS) was also performed on all phases detected. Three samples were studied: (1) as-received, (2) no salt coating and annealed in argon, and (3) sodium sulfate coated and annealed in oxygen. Both heat treatments were performed at 900 C for 100 hours. Sample (1) matrix was composed of small stoichiometric grains of Betaspodumene (Li_20-Al_20_3-$4Si0_2$) and mullite ($3Al_20_3$-$2Si0_2$) in a high silica glass (88 wt% $Si0_2$ and 12 wt% Al_20_3). The fiber/matrix interface consisted of an amorphous $Si0_2$ and graphitic carbon layer. Sample (2) showed a substantial decrease in mullite content with a concomitant increase in the alumina content of the glass and crystalline phases. The interface morphology appeared unchanged by annealing in argon. Sample (3) suffered considerable hot corrosion. The matrix was a very fine mixture of glass and Beta-spodumene polycrystallites (20 nm in diameter). The fiber/matrix interface was extensively corroded and formed an alternating layered structure of graphitic carbon and amorphous $Si0_2$.

DIMENSIONAL PLANER PRESSURIZED AIR LABYRINTH SEAL TEST RIG

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A two-dimensional planer labyrinth seal test rig was designed to operate with air supplied at 45 psig and temperatures up to 150° F. The rig operates with a manually specified test section pressure up to 30 psig yielding Mach numbers to 0.9 and gap Reynolds numbers to 100,000. The air flow rate through the seal will be controlled by setting inlet pressure and adjusting an outlet control valve. The test section measurements are 18 inches wide by 1.5 inches depth by 6 inches in length and provides for 10:1 large scale geometry seals to be used to facilitate measurements. Design maximum seal gap size is 0.15 inches. The test section has a glass viewing port to allow flow field measurement by non-intrusive means such as Laser Doppler Velocimeter (LDV) with seals containing up to 5 sealing knives. Measurements of pressure, temperature and flow fields can also be simultaneously measured by probes inserted in the seal itself, or mounted on the removable/replaceable top plate. Inlet flow is conditioned through the use of a dump diffuser incorporating screens, honeycombs, expansion and contraction portions. The inlet flow to the test section can be modified from uniform to various non-uniform conditions by employing profile generators such as screens and winglets. A detailed mechanical design has been conducted including stress analysis and seal flow rate predictions.

A STUDY OF THE DEFORMATION OF HELICAL SPRINGS UNDER ECCENTRIC LOADING

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Much analysis has been done to date on the deformation of helical springs under normal loading. The aim of this study is to design a helical spring that will deform under eccentric loading a desired amount due to a given force. Under the assumptions of linear stress strain relationships, the spring will be designed in terms of its material properties and its geometry. The deformation of the spring will be made possible utilizing Shape Memory Alloy (SMA) active elements. Two models for spring deformation have been considered. In the first model we study the differential compression of a spring using SMA wire actuators, and in the second model we investigate the bending of as SMA rod placed inside the spring. Our efforts were a first step towards the development of a structural skeleton for a minimally invasive surgical manipulator.

ANALYSIS, APPROACH AND ASSESSMENT OF VIBRATION CRITERIA IN SHIPBOARD MACHINERY CONDITION MONITORING AND DIAGNOSTICS

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The setting of alarm levels plays a vital role in a machinery condition monitoring and diagnostic system. In this research, two approaches to setting vibration alarm levels using vibration signals produced by fire pumps are presented in the time and frequency domains. In the time domain, the cross peak analysis (CPA) is proposed to extract the dominate peak points. The distribution of these cross peak points is found to have a lognormal distribution and can be normalized to a Normal distribution in the VdB domain. The computed $\mu+2\sigma$ value in the VdB domain is suggested for use at the alarm level. In the frequency domain, the 1/1 octave band analysis (OBA) is introduced. Three artificial fault simulations are conducted to compare the 1/1 octave band method with the broadband method. The results show that the 1/1 octave band method is more sensitive to the changes in VdB level than the broadband method. The computer programs to perform these two analyses are written using MATLAB. Examples of the use of these programs are included in this report.

AN EXPERIMENTAL TESTBED FOR A FREE-FLOATING MANIPULATOR

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The attitude control of a multibody system in a gravity free environment has been an ongoing field of study for decades. Although most methods involve the use of thrusters, some algorithms exist that utilize internal motion of the system for reorientation. These algorithms reduce the expenditure of the limited amount of on board fuel so as to extend the useful life span of the system. An experimental facility for testing existing algorithms, and algorithms to be developed in the future for motion planning of multibody space systems, is developed as part of this research. The multibody system developed is comprised of a two link space vehicle/manipulator system. The system is mounted on air bearings and floats freely on a flat glass table. The robotic system is controlled in real time using a VME based controller with support from a SPARC station.

SODIUM SULFATE CORROSION OF SILICON CARBIDE FIBER-REINFORCED LITHIUM ALUMINOSILICATE GLASS-CERAMIC MATRIX COMPOSITES

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Sodium sulfate hot corrosion of a SiC fiber-reinforced lithium aluminosilicate (LAS) glass-ceramic matrix composite was studied using Scanning Electron Microscope (SEM) and X-ray Diffraction (XRD). Changes in the microstructural and chemical composition of the specimens were investigated. The samples provided by Naval Air Warfare Center (NAWC), Warminster, PA were grouped as follows: (1) as-received, (2) Na_2SO_4 salt-coated and heat-treated in oxygen, (3) noncoated and heat-treated in argon, (4) Na_2SO_4 salt-coated and heat-treated in argon, and (5) noncoated and heat-treated in argon. Heat treatment was performed by NAWC for 100 hours at 900° C. Experimental data obtained indicated that the presence of Na_2SO_4 in an oxidative environment resulted in rapid corrosion of the matrix and SiC fibers and in the latter rings of SiO_2 replaced what had previously been SiC. There was very limited degradation of the fibers and matrix exposed at the surface in the noncoated sample heat-treated in oxygen and in the salt-coated sample heat-treated in argon. A significant reduction in the amount of mullite in the matrices of all heat-treated samples was observed. Mullite dissolved into either the glassy phase or into the ß-spodumene matrix. Lastly, the presence of distinct magnesium silicate crystalline phases in the salt-coated and heat-treated in oxygen sample implies that the MgO at the surface reacted with the SiO_2 in the matrix.

USING THE ST1000/ST725 SONARS ON THE NPS AUV II

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Autonomous Underwater Vehicles (AUVs) require further technological development in several key areas (including sensor systems) in order to assume a broader role in undersea military and commercial environments. This research was an experimental investigation of the TRITECH ST1000 and ST275 high resolution sonar systems used onboard the NPS AUV II. Tests conducted with the ST1000 Profiler proved that the sonar could successfully be used in AUV positioning maneuvers but also revealed the requirement for some form of range dependent gain adjustment to ensure vehicle stability. The ST275 sonar was used in progressively complex static environments to clearly image objects. A scanline analysis of the ST275 data was shown to be useful in extracting stationary target information including range, bearing, and approximate size.

HEAT TRANSFER STUDIES ON A RECTANGULAR CHANNEL WITH OFFSET PLATE FINS

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Convective heat transfer characteristics of a liquid cooled rectangular channel, containing offset plate fins were investigated experimentally. The selected geometry was a 10x model of the fluid circulation passages found in the commercially available SEM-E type electronics cooling module. The test surface containing fins was made of aluminum and heated at its base by a thermofoil heater. The Reynolds numbers were varied between 100-800, with water as the cooling fluid. Surface temperature measurements on the heated surface were used to determine the Colburn j factor. The effects of natural convection were also investigated.

CONTINUOUS MEASUREMENTS OF AGING RESPONSE IN ALUMINUM ALLOYS BY EDDY CURRENT METHODS

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The objective of this research was to investigate further the use of a sensor system to continuously monitor the aging response of heat treatable aluminum alloys. This concept of continuous monitoring is referred to as "Intelligent Processing". The sensor consists of eddy current coils incorporated in an impedance bridge circuit, with modifications following earlier work by Esarey. The system continuously monitors a material property, resistivity, indicative of the aging process. The results of such continuous measurements, combined with mechanical test data, will allow one to gain active control of the aging process and hence the material properties of aluminum alloys. The ultimate results would be higher reliability of engineering structures. The increased precision i n control of heat treatment processes would allow more narrow performance and greater service life of engineering structures.

SPACECRAFT ATTITUDE CONTROL SYSTEM PERFORMANCE USING PULSE-WIDTH PULSE-FREQUENCY MODULATED THRUSTERS

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Many current satellites employ on-off thrusters to accomplish attitude control tasks which may include initial acquisition, rotational maneuvers, and on-orbit stabilization. This work shows that the use of pulse-width pule-frequency (PWPF)-modulated thrusters provides several important advantages over conventional bang-bang thruster control methods, including less thruster activity and closer-to-linear actuation. The PWPF modulator is implemented in simulators using the $Matrix_x$/Systembuild software package. Simulations assuming a rigid spacecraft are first performed to compare the performance of the PWPF-modulated thrust controller with that of conventional bang-bang and time-optimal bang-bang controllers. The discussion is then extended to the case of a spacecraft with structural flexibility, as is encountered quite often in three-axis stabilized vehicles with large fold-out solar arrays. Simulations for comparison of the controllers are performed using the flexible spacecraft dynamics model. The control loop design in the presence of flexibility and possible interaction with the PWPF modulator nonlinearity are addressed. Using a describing function model of the modulator, stability margin with respect to the structural mode limit cycle is predicted. Simulations are then conducted to verify the predicted stability margin.

NUMERICAL ANALYSIS OF SINGLE VORTEX/FREE-SURFACE INTERACTION

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The interaction of a single Lamb vortex with a free surface is analyzed numerically through the use of a finite-difference technique. The individual effects of gravity, viscosity, and surface tension are investigated within the range of the applicability of the phenomenon and the code used. The vortex is allowed to build up to its full strength in a relatively small time and then the evolution of the free surface, streamlines, and other details of the flow are calculated. The results have shown that the smaller the proximity of the vortex to the free surface, the larger the scar produced on its down-wash side. The effect of the surface tension is to reduce the amplitude of the free surface elevation. The viscous effects appear to be relatively small even though the calculations are, out of necessity, confined to a limited range of the governing parameters, as in all finite difference calculations.

THE INFLUENCE OF FIN HEIGHT AND WALL CONDUCTIVITY ON INTEGRAL FIN TUBES DURING STEAM CONDENSATION

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Heat transfer performance of horizontal integral-fin tubes made of copper, aluminum, copper-nickel, and stainless steel was evaluated using a boiler and steam condenser assembly. Testing was done at vacuum and atmospheric pressure conditions. The tubes tested had an inner diameter of 12.7mm, a root diameter of 13.88mm, and fin heights ranging from 0.5mm to 1.5mm, in 0.25mm increments. The outside heat transfer coefficient, U. then by using the Modified Wilson Plot Technique. The results indicated that the performance of a finned tube is very dependent on fin height and tube material. Moreover, the results were compared to the predictive models of Beatty and Katz, Rose, Adamek and Webb, and Honda et al., with a modified version of the Rose model demonstrating the best predictive capabilities.

X-RAY DIFFRACTION STUDIES OF EVAPORATED GOLD THIN FILMS ON ALUMINUM NITRIDE SUBSTRATES

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X-ray diffraction was utilized to determine the root mean square (r.m.s.) strains and average particle sizes in evaporated gold thin films on aluminum nitride substrates as a function of substrate surface condition prior to deposition. The substrate treatments evaluated were surface roughness, use of titanium and chromium inter-layers, presence of an oxide layer on the substrate surface and vacuum conditions used during deposition. The Warren-Averbach method was utilized to obtain the r.m.s. strains and particle sizes from peak breadth data, using both cosine and modulus methods. It was concluded that the highest strain deviations, and therefore, the largest film plastic deformation, occurred, when the substrate surface was rough, when chromium was used as an inter-layer and when ultra high vacuum conditions were used during deposition, may serve as an indirect measure of the interfacial adhesion.

SODIUM SULFATE CORROSION OF SILICON CARBIDE FIBER-REINFORCED CALCIUM ALUMINOSILICATE GLASS-CERAMIC MATRIX COMPOSITES

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Hot corrosion effects of Sodium Sulfate (Na_2SO_4) coated Calcium Aluminosilicate (CAS)/Silicon Carbide (SiC) reinforced glass-ceramic matrix composite were investigated using Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Analysis (EDX) and X-ray Diffraction (XRD). The samples provided by the Naval Air Warfare Center (NAWC) were unidirectional SiC/CAS as follows: (1) as received, (2) uncoated in air, (3) Na_2SO_4 coated in air and (4) Na_2SO_4 coated in argon. A heat treatment was conducted at 900° for 100 hours. Experimental observations indicated that the Na_2SO_4 coating in an oxidizing environment had severely corroded the silicon fiber resulting in a silica rich, Nepheline ($NaAlSiO_4$), Wollastonite ($CaSiO_3$), Rankinite ($Ca_3Si_2O_7$), Albite ($NaAlSi_3O_8$) and glassy phases. In the argon atmosphere fiber degradation was present although less severe than in the oxygen environment. Similar phases of silica rich, Nepheline, Albite, Rankinite, Mullite ($Al_6Si_2O_{13}$), Pseudo-Wollastonite ($CaSiO_3$) and a glassy region were present. Minimal fiber and matrix degradation was observed in the uncoated sample heat treated in air.

EFFECTS OF OBSERVER DYNAMICS ON MOTION STABILITY OF AUTONOMOUS VEHICLES

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The problem of loss of stability of marine vehicles under cross track error control in the presence of mathematical versus actual system mismatch is analyzed. For demonstration purposes, variations in the heading angle control gain are studied. Particular emphasis is placed on analyzing the effects of observer design on system response after initial loss of stability of straight line motion. It is shown that the dynamics of the observer may have a significant effect on the computed gain margin of the control system depending on the particular basis used.

TRIM EFFECTS ON MOTION STABILITY OF SUBMERSIBLE VEHICLES

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The effects of trim on stability of motion during depth control of submersible vehicles are analyzed. Full state feedback control is used to provide stable response in the dive plane, and feedforward control is used to ensure steady state accuracy. A complete set of stability maps is generated for various values of metacentric height, longititunal center of gravity/center of buoyancy separation, forward speed, and control law time constant. The results clearly indicate ranges of parameters that should be chosen in design and operation of a given vehicle.

A NONLINEAR STUDY OF OPEN LOOP DYNAMIC STABILITY OF SUBMERSIBLE VEHICLES IN THE DIVE PLANE

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This thesis presents a comprehensive nonlinear study of straight line stability of motion of submersibles in the dive plan under open loop conditions. A systematic perturbation analysis demonstrates that the effects of surge in heave/pitch are small and can be neglected. Primary loss of stability is shown to occur in the form of Hopf bifurcations to periodic solutions. Analysis of the periodic solutions that result from these Hopf bifurcations was accomplished through Taylor expansions, up to third order, of the equations of motion. A consistent approximation, utilizing the generalized gradient, is used to study of non-analytic quadratic cross flow integral drag terms. The results indicate that loss of stability occurs always in the form of supercritical Hopf bifurcations with stable limit cycles. It is shown that this is mainly due to the stabilizing effect of the drag forces at high angles of attack.

MAST-ANTENNA SURVIVABILITY: STRUCTURAL DYNAMIC DESIGN ANALYSIS BY COMPONENT MODE SYNTHESIS

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The structural survivability of shipboard mast/antenna systems subjected to underwater explosion can be "designed in", through the determination of the structural dynamics of the mast/antenna system. This thesis details the specialized application of accurate and efficient analytic methods for the structural dynamic design analysis of shipboard mast/antenna systems. Investigated herein are a class of substructing methods, generally referred to as component mode synthesis methods, which provide for the rapid calculation of dynamic response of the mast/antenna structural system to weapons effects. Additionally, the methods also provide for the simulation of live fire testing. The methods allow the individual antennae and the mast each to be independently modeled, arbitrarily combined, and the combined system dynamic response rapidly calculated to determine the structural survivability of a proposed mast/antenna configuration. This rapid and "modular" component-based analysis capability is specifically tailored for interactive computer-aided design analysis of shipboard mast/antenna systems.

A CONSTANT-DEPTH SCRATCH TEST FOR THE MEASUREMENT OF ADHESION AT FILM-SUBSTRATE INTERFACES

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This thesis reviews the development of the constant-depth Scratch Test for determining the adhesive shear strength of thin film-substrate interfaces, and proposes refinements to the theoretical analyses and experimental approach which were developed earlier. Modifications were made to incorporate a change in indenter orientation (for a Vicker's pyramidal indenter) as a measure to minimize damage during scratching. Additionally, the model was expanded to include the use of a conical indenter. A review of film failure modes was conducted, and the damage mechanism of forward lateral flaking was incorporated into the model. The data acquisition program was changed to reflect these modifications. Improvements were added to the previously constructed apparatus. Preliminary tests were conducted on chromium-on-glass samples, the results of which are also presented.

DEVELOPMENT OF AN EXPERIMENTAL FACILITY FOR ANALYSIS OF ROTORDYNAMIC PHENOMENA

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An experimental facility was developed to investigate the rotordynamic phenomena of rotating machinery during subcritical, resonant and supercritical operation. The facility consists of a Bentley Nevada Corporation Rotor Kit integrated with a computerized data acquisition and control process. A LabVIEW Virtual Instrument was designed to collect, analyze and display rotor position and rotor displacement information. Experiments conducted included construction of Cascade plots, analytic prediction of the first lateral mode and demonstration of synchronous whirl due to a mass imbalance; during which, backward whirl was experienced. The behavior of the rotor was characterized throughout the operating range.

VIBRATION ANALYSIS OF THE AN/SPS-67(V)3 SURFACE RADAR

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Modern warships rely greatly upon electronic systems for their combat effectiveness, as well as defense. The ability of the U.S. Navy to maintain sea control and to project sea power depends upon the state-of-the-art combat systems equipment. Shipboard combat systems must, therefore, be shock hardened to be capabile of operating in the combat shock environment. The structural survivability of the mast and antennae and hence, the shipboard combat systems, is a shock induced vibration problem in which relatively low frequency equipment responses are observed. The structural survivability of combat systems can be "designed in" through the application of modern digital techniques for measuring and analyzing dynamic phenomena. The purpose of this study was to build and demonstrate the practical value of a finite element model of the AN/SPS-67(V)3 surface search radar which when validated by experimentally obtained shock qualification data can serve as a powerful tool toward improving survivability of combat systems. The finite element model developed may be used to compute predicted shock-induced accelerations, velocities, displacements and shock spectra resulting from UNDEX in order to evaluate the potential for antenna structural survivability or velnerability on an existing platform. Futhermore the antenna finite element model may be used in the design of new mast-antenna systems.

ACOUSTIC POSITIONING OF THE NPS AUTONOMOUS UNDERWATER VEHICLE (AUV II) DURING HOVER CONDITIONS

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The ability to take position, in a dynamic environment, relative to a local stationary object, is vital to many planned missions for the Naval Postgraduate School's Autonomous Underwater Vehicle (AUV II) project, such as bottom surveying and mine hunting. The AUV II can achieve this ability through the use of its sensors, along with stern propulsion motors and tunnel thrusters. The sensors employed by the AUV II include a free directional gyro and independent self-sonar which provide acoustic positioning data without the aid of a transponder net. Described in this thesis are the details of the internal subsystems of the AUV II, and an examination of its positioning ability through the analysis of maneuvering experiments. Commanded motions of yaw, lateral and longitudinal positioning during hover conditions are studied.

ROTODYNAMIC EFFECTS DRIVEN BY FLUID FORCES FROM A GEOMETRICALLY IMPERFECT LABYRINTH SEAL

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The forces on a rotor due to asymmetric pressure distributions resulting from a single gland non-circular labyrinth seal in a circular outer casing are analyzed for the purpose of understanding the possible causes of synchronous vibration due to seal intolerance. A lumped model is developed for flow in the azimuthal direction inside the seal gland. The resulting continuity and momentum equations are solved using a regular linear perturbation technique. Results from this model indicate under what conditions seal imperfections can generate forces of the same order of magnitude as rotor mass unbalance.

STUDY OF FAILURE IN FIBROUS COMPOSITES SUBJECTED TO BENDING LOADS

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This study investigates the failure modes, failure strengths, and failure criteria of laminated composite plates with stress concentration and subjected to bending loading. Graphite/epoxy composites are used for the present study. Lamina material properties, such as stiffness and strength, of the composite are obtained by experiments. A series of bending tests are conducted for laminated, graphite/epoxy composite plates with and without a hole to investigate their failure modes and strengths. In addition, finite element analyses are performed to compute stress distributions around holes of the composite plates subjected to bending loading. Based on the stress computation, a couple of failure criteria are examined to predict the failure strengths of composite plates with stress concentration.

SYNTHETIC ENVIRONMENTS FOR C3 OPERATIONS

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Modeling, simulation, and display of information and situations have helped people make decisions since the first diagram was drawn in the mud. Today, computer hardware and software developments have advanced to allow very sophisticated and nearly real-time displays. The introduction of virtual reality simulations into the C3 environment can significantly improve the amount and display quality of information. World Tool Kit developed by Sense8 Corporation has been used to produce a simulation. The scenario has two opposing battle groups closing the distance of ocean between them, to demonstrate some of the potential advantages of this new and mostly untapped potential. The focus is on introduction of the technology into the C3 environment and will deal with some of the fundamental advantages and difficulties.

INTERACTION EFFECTS OF A LOWER HEATED TUBE ON POOL BOILING OF R-124 FROM AN UPPER HORIZONTAL TUBE

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An investigation of the interaction effects of a lower heated tube on pool boiling of pure R-124 from an upper horizontal tube was conducted at a saturation temperature of 2.2°778 C. The test tubes used were: (1) smooth tubes and (2) deformed surface (TURBO-B) enhanced tubes. The effects of tube spacing/configuration and lower tube heat flux on the heat transfer performance of the upper tube were investigated. For both tube arrays, the enhancing effect of bubbles from a lower tube was dramatic. This enhancement increased as lower tube heat flux increased. However, when upper tube heat fluxes were greater than 20 kW/m_2, all enhancement disappeared. For a smooth tube array in natural convection, the effect of a lower heated tube on the heat transfer from an upper tube was small. In nucleate boiling, a P/D of 1.8 gave the best upper tube heat transfer performance and a vigorously nucleating lower tube eliminated upper tube hysteresis. With the lower tube unheated and an upper tube heat flux of greater than 3 kW/m_2, the performance using R-124 was generally better than for R-114. With a nucleating lower tube (at 10 k/Wm_2), again the performance of R-124 was better, but only for upper tube heat fluxes of greater than 40 kW/m_2. For a TURBO-B tube array, a 30 degree offset of the upper tube reduced the upper tube heat transfer performance (compared to the in-line configurations). This may indicate bubbles depart TURBO-B tubes differently than smooth tubes.

TRAJECTORY PLANNING FOR SPACE MANIPULATORS

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The angular momentum of a free-flying multibody system in space is a conserved quantity. This conservation law acts as a nonholonomic constraint and manifests itself when cyclic motion of the articulated joints of an on board manipulator produces a net change in the orientation of the whole system. This poses two important and couples problems: (a) the motion planning problem of the manipulator for attitude reorientation of the space structure using internal motion of the joints, and (b) planning the manipulator joint trajectories that produce repeatable motion of all the configuration variables. We have adopted a surface integral approach to come up with algorithms for these nonholonomic motion planning problems.

MASTER OF SCIENCE
IN
METEOROLOGY

INTRASEASONAL OSCILLATIONS OVER THE TROPICAL WESTERN PACIFIC AND EASTERN INDIAN OCEAN FOR THE NORTHERN SUMMERS OF 1989-1991

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In this study we used data analyzed by the Navy Operational Global Analysis and Prediction System to study the intraseasonal oscillations other than Madden and Julian oscillation over the tropical western Pacific and eastern Indian ocean. The period of study is May-September of 1989, 1990 and 1991. Multiple-set canonical correlation (MCC), single point correlation and composite analyses were used to determine the structure of the disturbances. The results show that MCC mode #1 describes both the seasonal change and a near 20 day oscillation with a zonal half-wavelength around 3000-4000 km. The single point correlation and composites indicate that these oscillations are in gradient wind balance, transporting moisture northward, having upper level divergence over a surface low, and a warm-core structure. The seasonal change composite shows a quasi-stationary oscillation with May and June corresponding to the negative phase of MCC mode #1, and August corresponding to the positive phase of MCC mode #1. The near 20 day composite describes a westward propagation of 2.5-3° per day, with phase 2 corresponding to the negative phase of MCC mode #1 and phase 5 corresponding to the positive phase of MCC mode #1.

MASTER OF SCIENCE
IN
METEOROLOGY AND
PHYSICAL OCEANOGRAPHY

THE INFLUENCE OF CUMULUS PARAMETERIZATION ON MODEL FORECASTS OF RAPID OCEANIC CYCLOGENESIS

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Numerous studies have left little doubt that latent heat release (LHR) can significantly influence many features of extratropical cyclone systems. Recent experiments with the NCAR/PSU mesoscale model indicated that not only did different moisture parameterizations significantly affect model forecasts, but that forecasts for different cyclonic systems responded very differently to the parameterizations. Model output from the NCAR/PSU model is examined for two cyclonic systems, with four different parameterization experiments used to produce four forecasts for each system. The output was then examined in three and four dimensions to qualitatively and quantitatively determine the direct and indirect effects of latent heat release on model output. The results clearly showed the difference in the general dynamics of two cyclones. One demonstrated a very strong reliance on diabatic processes for its early development, becoming more adiabatic late in history, while the other initially developed very adiabatically and became more diabatic after about the mid-point of the forecast period. The cyclonic system that started out diabatically was more sensitive to moisture parameterization. The models clearly showed the differences between precipitation fields generated by the different parameterizations. In particular, allowing evaporation of precipitation in non-saturated layers greatly decreased the areal extent of light precipitation, while having minimal effect in areas of heavy precipitation.

CALIBRATION AND SEDIMENT LOAD ALGORITHMS FOR AN ACOUSTIC SEDIMENT FLUX PROBE

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A method to infer sediment concentrations from acoustic backscatter levels has been implemented for a prototype acoustic sediment flux probe. This required calibrations of the acoustic transceiver systems and direct measurements of the system response to typical sediment size distributions over a wide range of concentrations. The sensitivities of the 1.3 MHz and 5.2 MHz transducers of an acoustic sediment probe were measured using the backscatter amplitudes from stainless steel wires of four different radii. A two-frequency inversion algorithm estimating the geometric mean radius and variance about the mean of suspended sediment with an assumed lognormal size distribution and the sediment mass concentration was developed and tested in a laboratory setting. The sensitivity of the 5.2 MHz transducer for each wire was consistent within 10%. The sensitivity of the 1.3 MHz transducer calculated for each wire was not consistent and is believed to be due to a strong angular dependence between the wire orientation and the 1.3 MHz transducer face. The sensitivities of each of the four transducers were, however, inferred from the system's response to the controlled sediment backscatter measurements.

FLUXES ACROSS THE WEST COAST RESOLVED BY PICKET FENCE OBSERVATIONS DURING STORMFEST

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Meteorological features that force mesoscale weather systems that develop in the central U.S. often form far upstream over the data-sparse Pacific Ocean. It is hypothesized that the temporal and spatial resolution of the current rawinsonde network along the west coast may not be sufficient to detect and measure features moving inland. During the STORMFEST experiment in February-March 1992, a "Picket Fence" of seven rawinsonde stations were interspersed among the seven regular rawinsonde sites from Port Hardy, British Columbia to San Diego, CA. All sites obtained observations every 3 h rather than the normal 12 h. The objective was to examine the feasibility of utilizing extra observations in time and space to improve upstream boundary conditions for forecasts of mesoscale weather events in the central U.S. Fluxes of mass, heat, momentum, moisture, kinetic energy, and potential energy across the west coast resolved with various spatial and temporal combinations of Picket Fence data were compared with the 12-h regular site sondes as the standard. In the best case in which a wave system crossed the middle of the Picket Fence, significantly different fluxes were calculated with the full spatial and the 3-h Picket Fence observations. For other systems that crossed near the ends of the axis, only small changes were detected by the additional observations.

A COMPARISON OF MODELED AND OBSERVED OCEAN MIXED LAYER BEHAVIOR IN A SEA BREEZE INFLUENCED COASTAL REGION

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A high temporal resolution data set from a mooring in Monterey Bay, California was analyzed and used to calculate heat and momentum fluxes for the purpose of forcing two ocean mixed layer models. The time frame for the study was September 1992, a period representative of the sea breeze circulation frequency affecting this and other coastal regions. The models used were that of Price, Weller & Pinkel (1986), a Richardson number based on the turbulent kinetic energy budget within the mixed layer. Both models were analyzed with respect to their ability to reproduce the observed diurnal variation of the temperature and depth of the mixed layer. Although the model predictions agree reasonably well with observations in regards to the phase of the diurnal temperature cycle, they were seen to underpredict its magnitude, particularly the nocturnal cooling. This lack of cooling in the models relative to the ocean could be due to penetrative convection, non-steady state turbulence, and/or diurnal advection present in the ocean but not in one or both models. Additionally, the models exhibited an upward temperature trend relative to the data which caused progressively increasing stratification. This trendte the magnitude of vertical advective effects.

WAVE REFLECTIONS FROM BREAKWATERS

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A new method is presented for estimating the reflection of a random, multi-directional sea from a coastal structure. The technique is applicable to an array of wave gauges of arbitrary geometry deployed seaward of the reflector. An expansion for small oblique wave incidence angles is used to derive an approximate relationship between measured array cross-spectra and a small number of parameters that describe the incident wave properties and the reflectivity of the structure. Model tests with simulated array data demonstrate that for wave incidence angles less than about 30° the new technique provides accurate and robust estimates of the gross properties of incident and reflected waves. The new method is applied to array data acquired offshore of a permeable, rubble mound breakwater in Monterey Bay, California. The estimated reflection coefficients decrease approximately linearly with increasing frequency. Whereas the observed reflections depend only weakly on the incident wave energy, the fraction of the incident wave energy flux transmitted through the breakwater decreases with increasing wave energy, suggesting that dissipation is enhanced with large amplitude waves.

ENVIRONMENTAL FORCING OF AMBIENT NOISE IN THE NANSEN AND AMUNDSEN BASINS OF THE ARCTIC OCEAN

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The AREA 1992 experiment inserted three ANMET buoys on separate ice floes about 600 km north of Franz Josef Land. The buoys drifted in unison for most of the experiment and provided 12-19 months of hourly ambient noise data between 5 and 4000 Hz while obtaining limited weather data. The drift pattern was neatly divided into five legs of nearly uniform ice velocities in response to major changes in the wind field. The annual median spectra of each buoy were nearly identical at or above 200 Hz but diverged below 200 Hz. The largest differences were recorded between the two closest buoys. The annual spectra were 10 dB greater than the long term Eurasian Basin median spectra at all frequencies. The annual median spectra was 6-7 dB greater than the CEAREX 1988/89 median spectra below 100 Hz but was quieter than CEAREX above 100 Hz. Persistent extreme noise levels above the 95^{th} or below the 5^{th} percentiles were rare. Sustained 95^{th} percentile noise levels were caused by the ice field convergence resulting from storms passing near the buoy cluster. Sustained noise levels near the 5_{th} percentile occurred during periods of slow, steady winds. Temporal coherency of the year-long record ranged from 12-23 hours at all frequencies, comparable to other reported data. Significant energy was found at synoptic periods of 16-148 hours and near the tidal/inertial 12 hour period at all three buoys, implying the same forcing mechanisms were important in spite of buoy separations up to 300 km. Spatial coherency between the buoys showed the highest correlation between the closest buoy pair. Differences in correlation coefficients were smaller at higher frequencies due to the increased importance of local effects at higher frequencies. Ice speed was the best environmental correlate with ambient noise from 5-10 Hz, wind speed was best from 32-100 Hz, and wind stress was best above 100 Hz. Three periods of extreme noise levels (two loud, one quiet),each lasting for several days, were investigated in detail to establish the role of wind forcing on ambient noise generation. Periods of loud noise were associated with periods of high wind/ice speed coupled with rapid changes in direction, i.e., loud noise levels are the result of large ice convergence and shearing moment. Quite periods occur when the buoy drift speed is slow. One of the loud noise events showed that periods of ice convergence on nearby land will increase the noise level, even during times of moderate wind speeds.

EVOLUTION OF DIURNAL SURFACE WINDS AND SURFACE CURRENTS FOR MONTEREY BAY

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The diurnal-period fluctuations of winds and surface currents are analyzed for September 1992 in and around Monterey Bay. Wind records are compared for three coastal stations and two mooring sites. Remotely-sensed surface current observations from two CODAR (HF radar) sites are used to expose the ocean's response to diurnal-period forcing. An average diurnal cycle is formed at each wind station and at all CODAR bins. The earliest sea breeze response is seen at the coastal wind stations where morning winds accelerate toward the coastal mountain ranges. A few hours later, the coastal winds accelerate to the southeast down the Salinas Valley. Offshore afternoon winds rotate from their normal alongshore orientation to also become aligned with the valley. The CODAR-derived surface currents respond in less than the two-hour sampling rate to the onset of the diurnal onshore winds. Currents accelerate in the direction of the Salinas Valley. As the day progresses, the more offshore currents rotate clockwise out from under the winds in a possible Ekman or inertial adjustment that continues throughout the night and spreads onshore. In the afternoon, a complicated eddy pattern develops near shore in a possible response to the coastal boundary.

YELLOW SEA THERMAL STRUCTURE

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There exists a need in the oceanography community to be able to produce climatologies of remote or poorly sampled shallow water areas through remote sensing techniques. Our goal was to construct a three-dimensional thermal structure of the Yellow Sea based primarily upon sea surface temperature data. The ability to do this successfully could lead the way to applying these techniques elsewhere using remotely sensed SST. The shallow water and dynamic conditions of the Yellow Sea made it an ideal study area. The large MOODS observational data set for the area provided us with 15,000 observations from 1929 to 1991. For the winter months we used regression techniques on the predominately well-mixed, vertically isothermal profiles with excellent results. For the summer we applied a Feature Model which extracted physically significant depths and gradients from the observations. These modeled data were statistically compared with mixed results indicating little link between SST and mixed-layer depth but good correlation between SST and thermocline gradient. We believe interannual variability and significant sampling errors in our data contributed to our mixed results. Overall, we feel our approach is robust and has potential for further applications providing data quality issues are addressed.

AIR-SEA INTERACTION PATTERNS IN THE EQUATORIAL PACIFIC

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We have investigated air-sea interaction patterns in the equatorial Pacific during the 1991-1992 El Niño/Southern Oscillation (ENSO) event. Our study focused on the identification of spatial and temporal relationships between sea surface temperatures, subsurface temperatures, and winds. These relationships were examined using time series and statistical analyses of atmosphere and ocean data from the moored buoys of the Tropical Oceans-Global Atmosphere (TOGA) program. Our results strongly suggest that the heat content of the ocean mixed layer greatly affected air-sea interactions. In almost all regions, mixed layer warming was following within one week by increased winds. In most cases, the mixed layer warming before wind events was accompanied by a thickening of the mixed layer, suggesting that internal waves were strongly influencing air-sea interactions. Increased winds tended to precede surface cooling and subsurface warming by a few days. There were strong correlations between warming (cooling) thermocline temperature and increased (decreased) zonal winds at the central and eastern equatorial Pacific buoys. In the central Pacific, thermocline warming (cooling) was associated with westerlies (easterlies). This suggested that equatorially trapped Kelvin waves warmed and thickened the mixed layer, resulting in increased zonal winds. In the central Pacific, these local zonal winds then reinforced the Kelvin waves through downwelling and upwelling. Ocean temperature inversions were found throughout the Pacific. Such inversions were most pronounced in the central Pacific. The inversions in this region were associated with a relatively thick and warm mixed layer, and with relatively strong westerly winds and deep atmospheric convection. One particularly strong and persistent equatorial inversion event at 155° W apparently resulted from weak wind induced surface cooling combined with strong Kelvin wave induced subsurface warming. The westerly winds during this inversion were part of a tropical cyclone that formed just north of the equator. The air-sea relationships during this case study were consistent with those identified by the basis wide statistical analyses. Taken together, these results suggest the following remote feedback cycle. (1) Tropical cyclones in the west Pacific generate equatorially trapped Kelvin waves. (2) These waves propagate into the central and eastern Pacific, warming and thickening the mixed layer. (3) The warmer ocean generates wind events. (4) The wind events, coupled with the warmer ocean temperatures, create conditions favorable for tropical cyclone formation. (5) Tropical cyclones develop, and propagate westward into the west Pacific.

SYNOPTIC-SCALE INFLUENCE ON THE MONTEREY BAY SEA-BREEZE

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The diurnal fluctuations of the surface ambient wind associated with the sea-breeze are analyzed for the period May 01 through September 30, 1993 from a single station, Monterey airport, located on the southern Monterey Bay coast. Data analyzed included time series of wind speed, wind direction, clouds, precipitation and locally generated 3 hourly surface pressure analyses of California and the Pacific northwest. The characteristics of the sea-breeze circulation under varying synoptic-scale patterns are evaluated to determine the modifying roles of boundary layer stability, surface inversion strength, and low-level cloud amount on the resultant time of onset and peak intensity of the Monterey Bay sea-breeze. The primary modifying factor under all synoptic-scale pressure patterns was the boundary layer depth and stability with the differential heating taking longer to destabilize the boundary layer during the Trough regime.

THE EVOLUTION OF JET FEATURES DURING THE 1993 EAST COAST "WHITE HURRICANE": A CASE STUDY USING THE GLOBAL SPECTRAL MODEL

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During the period of 12 through 14 March 1993 a major snow storm, later described as a "White Hurricane," formed over the Gulf of Mexico, moved east-northeast across the Florida panhandle, and then headed northeast along the eastern seaboard. The extreme weather produced by this storm was responsible for 243 deaths and $1 billion in property damage. Because the storm was accompanied by unusually strong jet streaks, a diagnostic of the storm kinetic energy contents and generation of kinetic energy was undertaken. The vertically integrated kinetic energy (IKE) and vertically integrated generation of kinetic energy (IGK) are shown to be effective tools in determining how jet streaks influenced the development of this storm. Specifically, IKE can indicate geographically where jet streak maxima are located, whereas IGK can provide a measure of the effect of transverse circulations aloft. In addition, IGK combined with IKE can indicate if the jet streak is weakening or strengthening. The data used in this case study were primarily the National Weather Service's Global Spectral Model aviation forecast and analysis. These data were further interpolated for use in VISUAL, which is a meteorological diagnostic and display program developed primarily at the Naval Postgraduate School.

COASTAL BOUNDARY LAYER AND REFRACTIVITY MEASUREMENTS USING THE GROUND-BASED HIGH RESOLUTION INTERFEROMETER SOUNDER (GB-HIS)

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Timesections of potential temperature, dewpoint temperature, modified radar refractivity (M), and the vertical derivative of the modified radar refractivity (dM/dZ) from radiosondes and the Ground-based High Resolution Interferometer (GB-HIS) during three experiments are studied to analyze refractive effects in the coastal boundary layer and evaluate GB-HIS performance. In May of 1991 and 1992, the GB-HIS instrument was deployed on the Research Vessel Point Sur during research cruises off the central California coast. In August and September of 1993, the GB-HIS was deployed during the Variation of Coastal Atmospheric Refractivity (VOCAR) experiment at the Naval Air Station in Point Mugu, California. Comparisons of radiosonde observations with GB-HIS retrievals during the three experiments show that the GB-HIS is capable of depicting large-scale air mass changes in the coastal boundary layer with high temporal resolution. As a result the general location of some refractive layers in the coastal boundary layer can be determined with the GB-HIS data. Small scale features in the moisture timesections form the raob data were not resolved by the GB-HIS with significant skill. The inability of the GB-HIS to capture the vertical moisture gradients seriously limits its ability to monitor refractive conditions.

SHIPTRACK DATABASE ANALYSIS

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The radiative signatures of collected commercial and Navy shiptracks are described through an analysis of AVHRR (Advanced Very High Resolution Radiometer) satellite imagery. The analysis is conducted in a format to show the usefulness of a database approach to processing large amounts of shiptrack data. Twelve cases are analyzed, 9 commercial shiptracks and 3 Navy shiptracks. Satellite imagery for the above 12 cases was collected during the summer months of 1993 off the western coast of the United States. Three hundred six Navy reports were associated with 55 satellite images. This data subset was subdivided and cross-referenced to provide statistical data on Navy track formation when a given report was under favorable track formation conditions. Reflectance signatures of the collected tracks show an increase through the first few hours of track formation. Emittance values of the tracks collected from night-time satellite imagery showed the expected decrease as droplet radius decreases. Nuclear powered vessels showed no evidence of track formation. The utility of database analysis for large datasets of observed shiptracks was demonstrated to be a viable method for future analysis of the 4000+ observed shiptracks in the collected imagery.

AN ANALYSIS OF EDDY RESOLVING GLOBAL OCEAN MODELS IN THE SOUTHERN OCEAN

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Comparisons between the two model runs, a half degree resolution and a quarter degree resolution of the Semtner-Chervin eddy resolving global ocean model and the Hydrographic Atlas of the Southern Ocean (Olbers et. al, 1993) observations are conducted by analyzing horizontal and vertical sections. The model is shown to produce very realistic circulations and temperature and salinity distributions. Volume transport and meridional volume and heat transports are also calculated. The quarter degree model shows marked improvement over the half degree model although both models have salinities to the south and near the surface which are higher than those observed. This could be due to errors in surface flux parameterizations. Improvement in this area and in vertical resolution of the model will improve this global three dimensional model. More thermohaline observations in the Southern Ocean as is being attempted by WOCE (World Ocean Circulation Experiment) will also help achieve more accurate simulation of deep convection resulting in a more realistic abyssal circulation.

CHARACTERIZATION OF TIDAL CURRENTS IN MONTEREY BAY FROM REMOTE AND IN-SITU MEASUREMENTS

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A first order description of tidal heights and currents in Monterey Bay is provided. Analysis of sea level records indicate that a mixed, predominately semidiurnal tide nearly co-oscillates within the bay. Analysis of month-long moored ADCP records obtained in the winter and summer of 1992 reveals that tidal-band currents account for approximately 50 percent of the total current variance in the upper ocean (20-200m). A relatively strong (7 cm/s) fortnightly tide (MSf) is present in both seasons. Considerable rotation of the semidiurnal ellipse orientations occurs with depth during both seasons. A month-long record of surface current measurements obtained with CODAR, an HF radar system, during September 1992 reveals that the Monterey Submarine Canyon clearly influences the strength and direction of semidiurnal (M2) tidal currents. Good agreement exists between the strength and orientation of ADCP- and CODAR-derived tidal ellipses, with the exception of the constituent K1. Large, spatially uniform K1 surface currents (20-30 cm/s) appear to be the result of diurnal sea breeze forcing.

THREE DIMENSIONAL VISUALIZATION OF A COASTAL MESOSCALE MODEL

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An atmospheric coastal mesoscale model is visualized using a high speed graphical computer workstation. Output from a 36-h model forecast of the Naval Postgraduate School (NPS) research version of the Naval Research Laboratory (NRL) limited area grid model is displayed at 30 minute time steps. The NPS/NRL model is centered on the California coastal region. Using the graphical software package VIS-5D, three-dimensional scenes are developed that show the interrelation of model parameters which aid in understanding model output. The visualization is used to evaluate wind flow, temperature and moisture patterns, shortwave and longwave radiation parameterization, and cloud simulations for the time period 0000 UTC 02 May 1990 to 12000 UTC 03 May 1990. Additionally, model output is used to compute tactical displays of radar propagation used by the naval fleet meteorologist.

AN OBSERVATIONAL STUDY OF LONG WAVE IN THE EQUATORIAL PACIFIC OCEAN DURING THE 1991-1993 EL NIÑO

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Long wave in the equatorial Pacific Ocean during the 1991-1993 El Niño event were examined using temperature, current, and wind time series from the Tropical Oceans-Global Atmosphere Tropical Atmosphere-Ocean (TOGA-TAO) moored buoy array. Numerous episodes of long wave activity were detected. The most prominent episodes were associated with eastward propagating equatorial Kelvin waves and with westward propagating tropical instability waves and mixed Rossby-gravity waves. Equatorial Kelvin waves, which were generated by westerly wind events in the western and central Pacific, were evident in the data between 2°N to 5°S and from 170°W to 110°W. These Kelvin waves, which were most pronounced from 75 to 300 m, had periods of 40 to 70 days, eastward phase speeds of 1.9 to 6.5 m/s, and zonal wavelengths on the order of 10,000 km. These waves were most evident in the northern hemisphere fall and winter. The period of greatest Kelvin wave activity was August 1991-May 1992, during the peak phase of the 1991-1993 El Niño event. Tropical instability waves were most evident in the data between 8°N to 5°S and from 170°W to 110°W. These waves occurred during the northern hemisphere summer and fall and were confined to the upper 75 m. There was evidence of possible mixed Rossby-gravity waves in association with the tropical instability waves. These waves occurred between 8°N and 2°N and from approximately 100 m to 250 m. Both the tropical instability waves and the apparent mixed Rossby-gravity waves had similar westward phase speeds, 0.5 to 1.5 m/s, and zonal wavelengths, 1500 to 3000 km. The tropical instability waves and mixed Rossby-gravity waves had slightly different periods, 15 to 30 days and 25 to 30 days, respectively. There were strong negative correlations between the temperature time series associated with the tropical instability waves and that associated with the mixed Rossby-gravity waves.

SHORT TERM TELECONNECTIONS ASSOCIATED WITH WESTERN PACIFIC TROPICAL CYCLONES

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The short term teleconnections arising from an individual tropical cyclone in the western Pacific were examined using a global operational data assimilation system and forecast model. In the data assimilation, the tropical cyclone was modified using a tropical cyclone bogusing procedure that either maintained the storm in, or eliminated the storm from, the model's initial conditions. These different initial conditions were used as the initial fields for several 20 day runs of the forecast model. These runs were used to simulate the global atmosphere with and without the tropical cyclone. The differences between these simulations were used to infer the global teleconnection response to the tropical cyclone. This response was dominated by a strong, quasi-stationary Rossby wave train that extended from east Asia across the North Pacific into North America. This wave train was initiated when an anticyclonic circulation formed near Japan as the tropical cyclone approached the east Asian jet. The anticyclone formation was primarily the result of the absolute vorticity advection by the divergent wind and vortex stretching (i.e., the Rossby wave source) associated with the tropical cyclone. The wave response continued to develop after this wave source, and the tropical cyclone itself, dissipated. This development was clearly seen in the growth and eastward propagation of Rossby wave energy across the midlatitude North Pacific and North America. The growth tended to be greater near areas of potential barotropic instability along with the North Pacific jet, while the propagation tended to occur parallel to the jet. The net effect of the tropical cyclone was especially evident in the North Pacific - North American region, where the model atmosphere with the tropical cyclone showed a midlatitude jet and storm track that were markedly different from the jet and storm track seen in the model atmosphere without the tropical cyclone. The two tropical cyclones investigated in this study were super typhoon Yuri (November-December 1991) and typhoon Robyn (August 1993).

TROPICAL CYCLONE DEVELOPMENT AND INTENSIFICATION UNDER MODERATE TO STRONG VERTICAL WIND SHEAR

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A study was conducted to understand the physical mechanisms by which a tropical cyclone is able to develop and be maintained under moderate to strong vertical wind shear. The general approach was to describe case studies of three tropical cyclones in the western North Pacific that developed and/or intensified in the lee of another tropical cyclone. The data resources include high temporal and spatial resolution visible and infrared satellite imagery, operational subjective and objective analyses, plus special Tropical Cyclone Motion (TCM-90) high resolution (50 km) analyses and multi-quadric analyses. The three tropical cyclones developed and/or intensified under moderate to strong vertical wind shear that exceeded threshold values. The vertical wind shear was time dependent due to complex interactions with the leading tropical cyclone outflow, adjacent tropical upper tropospheric trough, and large-scale environment. Diurnal variability in strength of convection and outflow against the impinging flow led to fully exposed, partially exposed, or covered middle to lower tropospheric cyclonic circulation. Special characteristics of the monsoon trough circulation must create and sustain the tropical cyclone circulation against the tendency for the vertical wind shear to ventilate the vertical thermal and convective structure.

A NUMERICAL STUDY OF WIND FORCING EFFECTS ON THE CALIFORNIA CURRENT SYSTEM

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A high-resolution, multi-level, primitive equation ocean model is used to examine the response of an idealized, flat-bottom, eastern boundary oceanic regime on a beta-plane to climatological average (1980-1989), individual year, and multiple year wind forcing. The focus of this study is the California Current System along the coastal region, from 35° N to 47.5° N, off the West Coast of North America. Two types of experiments are conducted. The first type forces the model from rest with climatological, 1981, and 1983 monthly winds to examine the generation phase of features such as currents, upwelling, meanders, eddies, and filaments. The second type continues the forcing from the previous years to examine the maintenance of these features. In the first type of experiments, the following features are observed: a poleward coastal surface current near the start and end of each year, an equatorward surface current, a poleward undercurrent, upwelling, meanders, and eddies. In the second type of experiments, meanders and eddies were already present at the start of the experiment. In addition to the features observed during the first type of experiment, filaments are generated. The results support the hypothesis that wind forcing is an important mechanism for the generation of many of the observed features in the California Current System.

MULTISPECTRAL NOAA MARINE ATMOSPHERIC BOUNDARY LAYER (MABL) ESTIMATES DURING VOCAR

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Satellite derived images of surface relative humidity and boundary layer height are generated from AVHRR data collected in a coastal region during the Variability of Coastal Atmospheric Refractivity (VOCAR) IOP (24 August - 03 September 1993) for comparison with in-situ data. The technique, proposed by Kren (1987) and verified by Smolinski (1988) uses channels 1,4, and 5 via the relationship between radiative extinction and relative humidity. The input variables measured are 1) sea surface temperature, 2) total atmospheric water vapor, from the split-window technique in addition to, and 3) aerosol optical depth, inferred from Channel 1 radiance. The assumption of total atmospheric water vapor confined to the MABL is relaxed. Satellite-derived boundary layer heights are brought into agreement with radiosonde measurements by varying the amount of water vapor confined to the MABL. Agreement between satellite and radiosonde measured heights and slopes is good. Spatial and temporal variability of refractive conditions over the region is large. The method appears capable of tracking the bottom of a trapping layer, associated with the inversion at the top of the MABL, inferred from radiosonde measurements. Comparison with the IR Duct Technique, an empirical method which applies to cloudy areas, shows promise for integration with this technique for clear areas.

THE EFFECTS OF WESTERLY WIND BURSTS ON A TROPICAL GENERAL CIRCULATION MODEL

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A primitive equation general circulation model with imbedded mixed layer physics has been used to investigate the response of the equatorial Pacific Ocean to daily varying winds and westerly wind bursts. The major issue addressed by this study is the impact of daily varying winds, including westerly wind bursts, in the modeling of the tropical Pacific Ocean and El Niño. In the developmental phase, the sensitivity of the model to the integration time step and the domain size were investigated. The results of this work were used to determine the optimal time step and model domain size for the main experimental model runs. In the experimental phase, the model was spun-up using time averaged wind stresses. The model ocean was then exposed to two years of realistic daily varying wind stresses covering the period of 1991 and 1992. The model developed an El Niño like response that corresponded in several respects with observed features of the 1991-92 El Niño. The model also developed tropical instability waves in the eastern Pacific similar to those observed in situ and in satellite SST images. The model's responses to the tropical cyclones that occurred during 1991-92 were also consistent in several ways with observations.

TEMPORAL AND SPATIAL DECORRELATION SCALES OF THE YELLOW SEA THERMAL FIELDS

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Historically, studies on decorrelation scales have been conducted in the deep ocean waters. As the Navy shifts its interest toward the less understood shallow water regions, decorrelation scales need to be computed in order to use formerly deep water models such as the Optimum Thermal Interpolation System (OTIS) for shallow water regions such as the Yellow Sea. A data set containing over 35,000 temperature profiles from 1929 to 1991 was obtained from the Naval Oceanographic Office's MOODS data set. The winter and summer seasons provide realistic results. Winter has the smallest decorrelation scales of all the seasons, approximately 15 days and 165 km. Summer shows that there are different decorrelation scales between the surface and at depth. The surface has scales of 12.3 days and 251 km while at depth the scales are approximately 16.5 days and 163 km. An observational sampling network design is suggested for future sampling of the region. Spring and fall provide mixed results which may be due to the irregularities in time and space of the data set or to the very complex forcing mechanisms found in the region. Overall, this study gives a ground work for better refinement of decorrelation scales and the ability to assess the conversion of deep water models to shallow water regions.

SHORT TERM TELECONNECTIONS ASSOCIATED WITH AN INDIVIDUAL TROPICAL CYCLONE

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The short term teleconnections associated with an individual western Pacific tropical cyclone have been investigated using an atmospheric general circulation model. The general strategy was to use the GCM, in combination with several tropical cyclone bogusing procedures, to isolate the effects on the global circulation of the tropical cyclone. The bogusing procedures were used to alter the tropical cyclone in the initial conditions for the model. The primary modeling experiments involved using the tropical cyclone bogusing procedures to include or exclude the tropical cyclone from the initial conditions. The difference between model results that contained the tropical cyclone and those that did not were used to analyze the global response to the tropical cyclone. These results showed a strong and persistent teleconnection response in the extratropical northern hemisphere. This response was mainly evident in slowly propaging Rossby waves in the 200 mb height field. Examinations of the teleconnection mechanisms showed that the east Asian-north Pacific jet played a major role in the development of the teleconnection. In particular: (1) the 200 mb height responses showed a consistent relationship with the jet; (2) the jet acted as a waveguide for the Rossby wave energy; and (3) the regions of potential barotropic instability which flank the jet were often colocated with areas of wave amplification.

MASTER OF ARTS
IN
NATIONAL SECURITY AFFAIRS

MARTYRS IN REVOLUTION: CAN THE SYMBOL SUSTAIN THE STRUGGLE?
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Master of Arts in National Security Affairs-March 1994
Advisor: Jan S. Breemer-Department of National Security Affairs

Martyrs have long been lauded as effective tools of mass persuasion. Once firmly identified with a variety of religious faiths, the martyr has just recently emerged within the secular world of politics and, in particular, within states embroiled in revolution. This thesis is a descriptive and analytical exercise which researches a number of areas concerning revolutionary martyrs. First, it examines the evolution of the martyr's character throughout its history. Next, it determines both the necessary and sufficient conditions which are present in the creation of martyrs in revolution. Third, the study suggests that some revolutionary martyrs possess a greater potential to arouse an incipient, latent community to support revolutionary movements. Finally, it offers a measurement scale to determine the effectiveness of a revolutionary's martyrdom to incite action and identifies those bureaucratic controls which may enhance and politicize the image within a population in turmoil. In so doing, it is the author's hope that this research can be fruitful to policy makers and operators within the Departments of State and Defense in their on going efforts to more clearly understand and effectively employ psychological operations in revolutionary conflicts throughout the globe.

RESTRUCTURING GCC SECURITY POLICY AFTER THE GULF WAR: PROBLEMS AND PRIORITIES
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Current security policy does not follow the logic of GCC defense needs. Giving the strategic realities of the GCC states (in particular their small population), there is no potential external enemy against which even well-armed and well-trained GCC militaries would be effective. Any potential adversary - Iran, Iraq and Israel - would be able to crush any GCC state with impunity in spite of any array of armaments these states could purchase. Put bluntly, no amount of defense spending would be effective against any realistically potential external enemy. The logic of the GCC's geostrategic position dictates, rather, a reliance on a Western defense umbrella to defend the GCC states from external threats, while diverting current defense resources to economic development. As the Gulf War demonstrated, the West will respond in force to any threat to the oil supplies of the GCC states. Demilitarization in the context of a Western security umbrella is not a novel policy as both Japan after WWII and currently Costa Rica have made similar calculations. Creating a small joint force-supported by the six countries-with high-tech, air superiority, and proper air defense, might serve to cope with limited hostilities, and act as a trip-wire and a means of buying time to invoke Western support. Such a policy would free up billions of dollars and substantial personnel for sustained economic development and social welfare.

POWER BY THE NUMBERS: CONGRESSIONAL LINE ITEM MANAGEMENT

Jeffrey H. Bell-Lieutenant, United States Navy
B.S., San Diego State University
and
Stephen B. Dowell-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1978
Master of Arts in National Security Affairs-June 1994
Advisor: Paul N. Stockton-Department of National Security Affairs

Congressional micromanagement of the defense budget is a crucial element of the struggle between the legislative and executive branches to shape military spending. By altering presidential funding requests, Congress can impose its own preferences on the defense budget, and thus guide the restructuring of U.S. armed forces. Congressional micromanagement has drawn enormous criticism from academics and Department of Defense officials. This thesis uses budgeting documents provided by the DoD Comptroller to conduct two related studies. The first is a multi year (Fiscal Years 1989-1994) trend analysis of the procurement account, which examines how the end of the Cold-War has affected micromanagement by congressional appropriators. The second study examines all defense budget categories for one representative year (FY1994) to compare the amount of micromanagement in procurement with that of other accounts. This thesis argues that the percentage of budget line items for procurement altered by congressional appropriators remained nearly constant (20 to 23 percent) from FY 1989-1994. Congress subtracted from more line items that it added to, however line item subtractions were smaller on average than additions. This thesis also found that Senate changes to individual line items were more likely to be retained in the final appropriations bill than were House changes. However, when averaged, line item changes proposed by the House were closer to the final conference average than those proposed in the Senate. A cross service analysis of defense appropriations line item budgeting revealed no particular service as the prime target of Congressional micromanagement, nor were any specific procurement programs within the services targeted above other programs. Finally, the single year cross sectional analysis revealed that the activity in the DoD procurement account is indicative of legislative change in the operations and research accounts, but not in construction and housing.

ADAPTIVE JOINT FORCE PACKAGING (AJFP):
A CRITICAL ANALYSIS

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This thesis explores the concept of Adaptive Joint Force Packaging (AJFP). Provided first is an overview of the concept itself, including the factors behind its development, the manner and scope of its implementation, and the benefits proponents claim it will bring. Also reviewed are the various concerns and criticisms that AJFP has created within the defense establishment. Among those are reservations about the concept's impact on unit integrity and doctrine, the role of the Chairman of the Joint Chiefs of Staff and the Joint Staff, training budgets, and traditional combat capability. Opposition to AJFP also involves perceptions that it will create an additional layer of bureaucracy, will conflict with other, uncoordinated, force packaging initiatives, will limit force-employment options to a fixed "menu," and finally, will never come to fruition. The discussion of pros and cons on both sides of the AJFP debate is followed by an overall analysis and evaluation. It is concluded that, on balance, the AJFP concept has considerable potential for helping the U.S. military adapt to the post-Cold War international security environment and smaller force structure. In particular, AJFP promises to bring a greater degree of effectiveness to U.S. military operations at the lower-end of the conflict spectrum, and allows the peacetime forward presence mission to be addressed by a full range of joint forces.

THE CHEMICAL WEAPONS CONVENTION VERIFICATION REGIME: A MODEL FOR THE NPT?

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In January, 1993, the Chemical Weapons Convention (CWC) was signed, completing the first step towards eliminating all chemical weapons. This treaty is the most comprehensive multilateral arms control treaty ever signed. The teeth of the CWC is a modern verification regime that includes traditional scheduled inspections as well as an innovative challenge inspection system: a party to the treaty may initiate a challenge inspection of another party if it believes there is a treaty violation. The CWC has been called a model for future arms control treaties. The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) has been in force for 25 years and has its fifth and final review conference in 1995. While the NPT has been both lauded and criticized over its lifetime, most authorities agree that it needs revision to meet the demands of the next century. One of the areas of the treaty requiring extensive review is the NPT verification process. This thesis examines the verification procedures delineated in the CWC and discusses the possibility of creating a similar verification regime for the NPT. It addresses the reasons why the CWC inspection might work for the NPT. It also addresses security questions that must be considered by a technologically advanced state, like the United States, before considering such a verification regime for nuclear weapons and nuclear technology.

TERRORISM AS A PSYCHOLOGICAL OPERATION: A COMPARATIVE ANALYSIS OF THE ZIONIST AND THE PALESTINIAN TERRORIST CAMPAIGNS

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Terrorism is a quintessential psychological operation, involving the use of violence to convey a message to multiple audiences. As a psychological operation, terrorism produces two effects; one propaganda and the other psychological warfare. The propaganda effects are informative, persuasive, or compelling among neutral, friendly or potentially friendly target audiences. The psychological warfare effects are provocative, disruptive, and coercive among enemy or hostile target audiences. By comparing the Zionist and the Palestinian terrorist campaigns, this thesis demonstrates how terrorism produces psychological warfare and propaganda effects on multiple audiences and the consequences of each. The success of the Jewish resistance resulted from a strategy of terrorism that identified the psychological vulnerabilities of certain audiences, controlled for the psychological warfare and propaganda effects on those audiences, and anticipated audience response. By comparison, the Palestinian terrorism was exclusively psychological warfare, which failed to propagandize their cause beyond their national constituency. In either case, the success or failure of terrorism should be understood in part by viewing their campaigns of terror through the prism of psychological operations.

THE BA'TH PARTY IN IRAQ: FROM ITS BEGINNING THROUGH TODAY

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The conventional wisdom concerning the future of Iraq after the Gulf War of 1990-1991 centers on the prospect of Saddam Hussein and the Ba'th Party being ousted from power. Should this happen, critics argue, peace, security, and predictability will return to Iraq in particular and the Middle East in general. This view of the situation is wrong. This thesis examines the political history of Iraq since the end of World War I, the formation of the Ba'th Party, and the Ba'th Party since its ascent to power in Iraq. Leadership, Institutionalization, Policies, and Legitimacy form the core of the Ba'th hold on power in Iraq. In its 25 years of power the Ba'th Party has improved the standard of living in Iraq and penetrated society such that any change of regime will result in only marginal and superficial change. The resulting leadership may call itself by other names, but the majority of people in positions of power will be holdovers from the Ba'th regime.

THE GREENING OF GLOBAL SECURITY: THE U.S. MILITARY AND INTERNATIONAL ENVIRONMENTAL SECURITY

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Master of Arts in National Security Affairs-December 1993
Advisor: Rodney Kennedy-Minott-Department of National Security Affairs

This thesis examines the roles and missions of the U.S. military, and compares them to potential international environmental conflicts. Five specific environmental issues are examined in detail: deforestation, fresh water, nuclear contamination, overpopulation, and ecological terrorism. Ten U.S. military roles are also examined in detail: communications, interdiction, enforcement, education and training, assistance, leadership, warfighting, surveillance, intelligence, and deterrence. Analysis reveals that the U.S. military can play a support role in the majority of the environmental conflict issues. Use of force roles apply to fewer of the environmental issues. The U.S. military's primary use of force role of warfighting applies only to one environmental issue.

UNDERGROUND MANAGEMENT: AN EXAMINATION OF WORLD WAR II RESISTANCE MOVEMENTS

Christian Eric Christenson-Lieutenant, United States Navy
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This thesis explores the methodologies employed by the underground resistance movements of World War II to manage the inherent difficulties associated with operating in a clandestine environment. Specifically, it examines the role of the underground, the advantages and disadvantages of operating underground and discusses the management procedures implemented by the clandestine organizations to address the topics of recruitment, internal security, leadership and command and control. The underground organizations are examined generically, recognizing that there are fundamental operating principles, management requirements and security dictates are universally applicable -- whether discussing World War II resistance movements or contemporary guerrilla groups.

SEALIFT AND THE U.S. MERCHANT MARINE: VULNERABILITIES AND IMPLICATIONS FOR DEFENSE

Jonathan Christian-Lieutenant, United States Navy
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Master of Arts in National Security Affairs-December 1993
Advisor: R. Mitchell Brown III-Department of National Security Affairs

This study determines which of the two critical variables--vessel or personnel availability--will have the greater impact on strategic sealift given the post-Cold War geo-political and fiscal environment, and examines the key implications of a depressed U.S.-flag Merchant Marine (and maritime industry) on contingency planning. In addition to reviewing the evolution and development of the U.S. Merchant Marine and considering the repercussions of past legislation on the current state of the industry, a synopsis of recently-proposed maritime reforms and government-administered sealift programs is provided. Further, shipbuilding and maritime labor trends are discussed. Using Operations *Desert Shield/Storm* as a conceptual model for future sealift scenarios, this analysis concludes that *mariner* availability, not ship availability, will be the sealift "Achillés heel" in a nearly simultaneous two MRC scenario. This study includes the views of maritime industry representatives and government officials as a primary source data, and offers recommendations on potential sealift manning options and opportunities.

POLITICAL ETHNICITY: A NEW PARADIGM OF ANALYSIS

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Ethnic conflict is a contemporary issue plaguing many states as the international system moves toward a "New World Order." However, despite the importance of ethnic-based violence and nationalistic social revolutions, current conflict theories do not adequately explain the fundamental dynamics of ethnic conflict or provide clear prescriptive policy guidance. This thesis articulates a model that describes and explains ethnic conflict. The fundamental purpose of this effort is two-fold. First, it provides a method to objectively examine and describe the fundamentals of ethnic-based conflicts, social, and political revolutions. Second, the paradigm provides decision makers with important prescriptions for foreign and domestic policies *vis-a-vis* ethnic conflict. To accomplish this goal, the thesis is divided into three main sections. Section one outlines the Political Ethnicity model. This four part model provides a simple yet powerful theoretical tool for analyzing ethnic conflict. Section two applies the model to three case studies. These illustrative case studies demonstrate the explanatory effectiveness of the Political Ethnicity paradigm in actual instances of ethnic conflict. Section three applies the conclusions drawn to guide policy decisions at both the international and domestic level. This systematic approach to ethnic conflict should provide policy makers in both the State and Defense Departments with a useful and objective decision making tool. The Political Ethnicity model dispels the mystery and myths that often surround contemporary ethnic conflicts.

POTENTIAL HOSTILE MILITARY USE OF GPS

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This study examines the threat to United States forces from foreign military use of the Global Positioning System (GPS). GPS is a satellite-based navigation system that provides highly accurate geo-position, velocity and time information. GPS system characteristics and information availability are discussed. A case study of U.S. use of GPS during Operations DESERT SHIELD and DESERT STORM is presented. Various potential hostile military uses of GPS are discussed, accompanied by the technical requirements for foreign military forces to implement GPS. The conclusion is that, if there is a human interface between the GPS receiver and its intended military use, then a threat from GPS already exists. Additionally, if there is a non-human interface between the GPS receiver and its intended military use, then a threat may exist if certain technological conditions are met. Various options and recommendations for dealing with foreign military use of GPS are also presented.

THE U.S. ANDEAN DRUG STRATEGY: WHY IT IS FAILING IN PERU

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Advisor: Thomas C. Bruneau-Department of National Security Affairs

This thesis will demonstrate Peru's inability to physically operate and politically control large sections of the country, is the result of eroded internal state sovereignty. The decline of Peru's internal sovereignty is a function of economic, ethnic, and social clevages which have remained virtually unchanged since the Spanish Conquest of the Inca in 1533. As a result, Peru evolved into a polarized society, which is ethnically and culturally divided, with a substantially wide margin existing between state authority and rural social autonomy. This marginalization of state sovereignty has facilitated the emergence and growth of the Shining Path insurgency, which has coupled with the expanding cocaine trade. Together these two processes have accelerated the erosion of sovereignty in Peru. Given this reality, the policy goals of supply reduction set forth by the 1992 National Drug Control Strategy remain unattainable in Peru, and have little prospect for success.

IRAN'S SECURITY DILEMMA

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Since the fall of Mohammed Reza Shah in 1979, the Islamic Republic of Iran has remained politically isolated from the United States and the West. After eight years of brutal war with Iraq, Iran has embarked on a major effort to rebuild its devastated military. A major element of its military reconstruction has been the acquisition of advanced weapons systems with strategic applications, such as long-range bombers, submarines, advanced underwater mines, and ballistic missiles. Iran is also suspected of pursuing the development and acquisition of weapons of mass destruction. Given Iran's latent hostility towards the United States and its past willingness to engage in terrorism, these activities are a most serious concern. This thesis will examine Iran's strategic motivations, beliefs, intentions and capabilities, as well as the potential impact of these capabilities on U.S. interests in the Persian Gulf. It will also examine a range of U.S. policy options in response to Iran's pursuit of strategic military capabilities.

PRECIPITATING THE DECLINE OF TERRORIST GROUPS A SYSTEMS ANALYSIS

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This thesis shows how a government actor can use systems theory to hasten the decline of a terrorist group. The author assumes terrorist groups are social organizations, therefore terrorist groups come to value organizational survival over ideological or programmatic achievements. The same determinants that cause social organizations to decline will cause terrorist organizations to decline. Using systems theory to model terrorism as a system, it is possible to show how to influence these determinants to increase the terrorist group's rate of decline. The systems model allows a government actor to build intervention strategies tailored to counter a specific terrorist organization. The government actor can use the model to identify and then target the terrorist's weak points. It also enables the government actor to determine its own strengths and to use them against the terrorist system weak points. Finally, the analysis tests the model against case studies of the Red Brigades in Italy, and the Front De Liberation du Quebec (FLC) in Canada. A case study of Abu Nidal tests the proposition that terrorist groups, like other social organizations, eventually come to value organizational survival over ideological or programmatic achievements.

NUCLEAR PROLIFERATION AND LATIN AMERICAN SECURITY: IS THE "BOMB" PROGRAM DEAD IN BRAZIL?

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This thesis addresses the question of Brazil's hidden agenda in order to support one of the most advanced nuclear research and nuclear power programs in Latin America. From the early 1970s to the late 1980s Brazilian military leaders pursued the development of nuclear weapons. With the emergence of democratic regimes at the end of the 80s, these covert projects were halted or supposedly terminated. The civilian administration in Brazil is now supporting an ambiguous and uncompromising position by not ratifying significant agreements renouncing nuclear weapons programs. With Brazil still rejecting the Non-proliferation Treaty (NPT), not formally embracing the Tlatelolco Treaty (which prohibits nuclear weapons in Latin America), and not allowing full implementation of inspections and International Atomic Energy Association (IAEA) Safeguards on its nuclear facilities, the future of the Brazilian nuclear program appears to be a dormant but potential political factor in Brazilian foreign policy.

POWER BY THE NUMBERS: CONGRESSIONAL LINE ITEM MANAGEMENT

Stephen B. Dowell-Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1978
and
Jeffrey H. Bell-Lieutenant, United States Navy
B.A., San Diego State University
Master of Arts in National Security Affairs-June 1994
Advisor: Paul N. Stockton-Department of National Security Affairs

Congressional micromanagement of the defense budget is a crucial element of the struggle between the legislative and executive branches to shape military spending. By altering presidential funding requests, Congress can impose its own preferences on the defense budget, and thus guide the restructuring of U.S. armed forces. Congressional micromanagement has drawn enormous criticism from academics and Department of Defense officials. This thesis uses budgeting documents provided by the DoD Comptroller to conduct two related studies. The first is a multi year (Fiscal Years 1989-1994) trend analysis of the procurement account, which examines how the end of the Cold-War has affected micromanagement by congressional appropriators. The second study examines all defense budget categories for one representative year (FY1994) to compare the amount of micromanagement in procurement with that of other accounts. This thesis argues that the percentage of budget line items for procurement altered by congressional appropriators remained nearly constant (20 to 23 percent) from FY 1989-1994. Congress subtracted from more line items that it added to, however line item subtractions were smaller on average than additions. This thesis also found that Senate changes to individual line items were more likely to be retained in the final appropriations bill than were House changes. However, when averaged, line item changes proposed by the House were closer to the final conference average than those proposed in the Senate. A cross service analysis of defense appropriations line item budgeting revealed no particular service as the prime target of Congressional micromanagement, nor were any specific procurement programs within the services targeted above other programs. Finally, the single year cross sectional analysis revealed that the activity in the DoD procurement account is indicative of legislative change in the operations and research accounts, but not in construction and housing.

RIGHT FACE
UNDERSTANDING GERMAN POLITICAL DEVELOPMENTS

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Before unification in 1990, Germany experienced a rise in right-wing violence and political popularity. The trend has continued until the present. Many scholars attribute the phenomenon to the economic and social impact of unification and the wave of immigrants pouring into Germany. This is only partly true. Since the trend began before unification, then the real roots lie somewhere else. This thesis suggests that the rise in right-wing extremism is linked to the growing pressures of post-industrialization. Changes in modes of production, further globalization of economies, the information explosion, and the mobility of the world's capital, are causing new opportunities and dangers for people. Lost jobs or pay cuts are resulting in the West from the move to robotics, and from businesses heading for cheaper labor markets. Germany is not alone in facing these challenges. Most Western states are confronting the same problems. However, Germany's Nazi past makes it seem very different.

BRITISH RADIOACTIVE WASTE, TRANSNATIONAL ENVIRONMENTAL DEGRADATION, AND THE POST-COLD WAR REDEFINING OF NATIONAL SECURITY

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The radioactivity level in the liquid effluent discharged from the Sellafield (UK) nuclear fuel reprocessing plant exceeds the U.S. radioactivity concentration limits for such discharges. The effluent discharge from Sellafield in 1992 contained the least radioactivity of any published year's discharge. That year was used for detailed analysis. This fact is extrapolated to comment on discharges from previous years, when radioactivity levels discharged were hundreds or even thousands of times higher, depending on nuclide considered. The use of the Irish Sea as a diluent for the highly concentrated radioactive liquid discharged from Sellafield is ill-advised from an oceanographic standpoint. The radioactivity discharged into the Irish Sea and North Sea from Sellafield raises issues of the health effects of chronic low-level radiation exposure and the role of transnational environmental degradation in the post-Cold War redefining of national security.

INTERNATIONAL AND REGIONAL TRENDS IN MARITIME PIRACY 1989-1993

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Advisor: Gordon H. McCormick-Department of National Security Affairs

This thesis records the results of a data-based analysis of worldwide maritime piracy incidents against commercial merchant shipping from January 1989 to September 1993. The intent of developing this database was to create the framework that permits a rigorous statistical analysis of maritime piracy. It begins with a *descriptive* assessment of the scope and impact of piracy worldwide. Next, it identifies the statistically supportable regional and international trends in maritime piracy over the last five years. The database has been designed at the unclassified level to allow maximum access by the intelligence community and the commercial shipping industry. The database includes 523 reported cases of piracy. Piracy is defined as the act of boarding any vessel with the intent to commit theft or other crime and with the capability to use force in the furtherance of the act. Both incident details and ship characteristics have been incorporated in the database. The ultimate goal has been to develop a comprehensive statistical picture of where piracy occurs and how pirate attacks are carried out.

COMMAND AND CONTROL IN NEW NUCLEAR STATES: IMPLICATIONS FOR STABILITY

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Command and control systems of new nuclear states are likely to fail when placed under stress. This thesis will demonstrate that such failures can dramatically affect regional or international stability. Describing the current argument over the consequences of nuclear proliferation between proliferation pessimists and deterrence optimists, this thesis shows how C2 is in fact the crux of the debate. This thesis develops an analytical tool that may be applied to new nuclear states in order to classify their C2 systems and to predict when and how these evolving systems might fail. To show the tool's usefulness, it is applied to Ukraine, an important new nuclear state. This thesis also suggests several implications for U.S. foreign policy.

THE UNITED STATES, SAUDI ARABIA AND ARMS: PROSPECTS FOR FUTURE INSTABILITY IN THE ALLIANCE

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Advisor: Ralph H. Magnus-Department of National Security Affairs

The primary purpose of this research is to examine Saudi Arabia's relationship with the United States as it pertains to Arms. In examining this bi-lateral relationship, the research will attempt to answer two questions: First, what is the United States government's view on arms sales to its allies and how does it effect Saudi Arabia? Secondly, since the Reagan administration, Persian Gulf War, and the demise of the U.S.S.R., what factors of instability within Saudi Arabia, may be indicators, that the U.S. should re-evaluate it Arms policy? The methodology used will be a historical and economic assessment of U.S. and Saudi Arabian Arms relationship, with particular focus on the economic and political weaknesses within Saudi Arabia, and implications they may have for instability in the region.

MONITORING TECHNOLOGY PROLIFERATION: AN OPEN SOURCE METHODOLOGY FOR GENERATING PROLIFERATION INTELLIGENCE

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Master of Arts in National Security Affairs-December 1993
Advisor: Robert E. Looney-Department of National Security Affairs

This thesis develops a methodology to monitor technology proliferation. It is designed to provide proliferation intelligence on specific threat technologies and can be used to augment export controls or enhance counter proliferation initiatives. A high-tech component used to upgrade underwater mines is the subject of the case study developed in this thesis. This technology monitoring method exploits the exponentially expanding volume of open source information occurring as a result of the information revolution.

THE NATIONAL INTERESTS OF THE UNITED STATES IN SOUTHEAST ASIA: POLICY CHANGES FOR THEIR PROTECTION AND PROMOTION SINCE THE WITHDRAWAL FROM THE NAVAL BASE AT SUBIC BAY

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In November 1992, the United States withdrew its military forces from facilities in the Republic of the Philippines. The United States must now reassess its commitments, and the means and policies it will employ in protecting and promoting national interests in the post-Cold War era. This thesis examines the author's perceived global national interests of the United States in the post-Cold War era, based upon the Preamble of the United States Constitution. United States national interests abroad include protection of American lives and property, economic prosperity, and international goodwill. The perceived national interests of the United States in the East-Asia/Pacific region, with particular emphasis placed on the Southeast Asian sub-region, are discussed. This thesis then examines the political, social, and economic evolution of the Southeast Asian sub-region, including the Association of Southeast Asian Nations (ASEAN), and historical United States national interests in the Southeast Asian sub-region. Past means and policies of the United States to protect and promote its interests in the Southeast Asian sub-region are also reviewed. Finally, the opportunities and challenges now facing the United States in devising future means and policies to promote and protect United States national interests, as well as those of other nations, in the East-Asia Pacific region, are explained.

PRESIDENTIAL APPROACHES TO ORGANIZING FOREIGN POLICY MECHANISMS

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The organization of foreign policy mechanisms will determine the types of policies a President can create. Presidents organize their administrations using a formalistic, collegial or competitive approach. In order to manage foreign policy a President must develop a balance between formalistic and collegial approaches. This thesis analyzes how the Eisenhower and Kennedy Administrations structured their national security organizations and examines their policy decisions towards the Vietnam crisis. Eisenhower used a formalistic approach to create a highly structured organization with defined procedures to review foreign policy issues. Kennedy's style was far less rigid and relied on a high degree of personal interaction and group problem solving. This thesis demonstrates that there was a direct relation between the manner in which the US foreign policy apparatus was structured and the decisions that were made to escalate US involvement in the Vietnam War. This thesis concludes that the formalistic and collegial approaches are complimentary and that a President should utilize a combination of both approaches.

UNDOING FEUDALISM: A NEW LOOK AT COMMUNAL CONFLICT MEDIATION

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This paper argues that modern intra-state communal warfare exhibits several unique qualities that distinguish such conflicts, significantly, from the wars in America's historical experience. It demonstrates that identifying the *social constructions of reality* is a central task for analysts seeking to comprehend the characteristics that define communal conflict. It explains that the *objectives* for which communal conflicts are waged are often perceived as indivisible, zero sum contests in the most absolute sense and thus differ, fundamentally, from those upon which many inter-state wars of politics are predicated. It illustrates the pernicious but seldom discussed effects of *incoherent force structure* which provide both the catalyst to escalation and an unavoidable obstacle to negotiations. It concludes that the state-based, implicitly coherent, "rational actor" paradigm for international relations is simply inadequate for the task of analyzing and describing communal conflicts which manifest no such characteristics. The paper proposes a two-fold conceptual strategy for mediation based upon the extent to which a given conflict has escalated, and the level to which its internal force structure has fragmented toward incoherence. The proactive strategy addresses conflicts at an early stage and applies a sociological approach to *disarm* misperceptions and deconstruct conflict. The reactive strategy requires a forcibly imposed ceasefire followed by extensive sociological, economic, and psychological approaches toward *undoing feudalism*, that is, toward reunifying fragmented communal society.

DEMOCRACY AND TUNISIA: A CASE STUDY

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Since the fall of the Berlin Wall and the demise of the former Soviet Union, the promotion of global democracy and free markets along with the principles of human rights have become paramount to U.S. interests and foreign policy. The significance of attaining global democracy has been fueled by the proposal that liberal states do not go to war with other liberal states which in the post-Cold War environment suggests a correlation between democracy and world peace. This thesis will support the hypothesis, using Tunisia as an example, that U.S. foreign policy for global democratization will elicit the use of democracy as a window dressing in order for a country to foster and enhance foreign investment rather than to move toward democratic reform.

COCOM AND THE FUTURE OF CONVENTIONAL ARMS EXPORTS IN THE FORMER COMMUNIST BLOC

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and
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This thesis describes the realities of the military industry in some of the key countries in the Former Communist Bloc (FCB) and their perspective on the role that military exports plays in their political and economic structures. Furthermore, the thesis asserts that, because of increased transfers of high technology and changing economic imperatives, weapons exports from the FCB pose a potential threat to the United States' ability to exercise political and military options in international affairs. Finally, the thesis proposes a solution to the problem noted above. The thesis argues for a series of changes to the CoCom structure that will combine the particular demands of the evolving FCB states with the realities of the modern world. In doing this, the thesis proposes a new conceptual framework for CoCom as well as specific actions to reduce the deleterious effects of arms sales from the FCB.

U.S. EMBARGO AGAINST CUBA: SHOULD IT BE CONTINUED?

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With the end of the Cold War, it is time for the United States to reassess its embargo against Cuba. Without the help of the former Soviet Union and the Eastern bloc countries, Cuba is no longer a threat to the United States. While the embargo, in conjunction with the loss of Soviet support, is imposing severe economic hardship on the Cuban population, Fidel Castro and his regime continue to hold their firm grip on the country. Thus, the ultimate goal of destabilizing the government has not been reached. In order for the United States to be in a position to encourage and influence a transition to democracy in Cuba, instead of the chaos that could result from destabilization, it should work toward closer relations with Cuba by ending the embargo, encouraging U.S. investment in Cuba, and a freer exchange of information and ideas.

TO MEGALI IDEA - DEAD OR ALIVE?
THE DOMESTIC DETERMINANTS OF GREEK FOREIGN POLICY

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This paper discusses *to megali idea* or the "Great Idea," which is at the origin of modern Greek nationalism. The "Idea" was to regain lands which formerly belonged to the Greek empire. The current Greek government's official line disavows any expansionist views, but the "idea" has never really died. In amplification of this Idea and its ramifications, the origin and the character of Greek nationalism are examined, especially as they pertain to the formation of Greek foreign policy. The problems of minorities within Greece, the Greek diaspora and the influence of the Greek Orthodox church on foreign policy issues are also analyzed. The findings aid in a greater understanding of Greek foreign policy both in today's Balkan crisis and in Greece's ongoing conflict with Turkey, as well as illuminating the potential for Greece's involvement in future Balkan crises. Many of the conclusions presented in this paper were based on primary language research and interviews throughout mainland Greece and eighteen of the major islands, from September through November 1993. National elections which brought to power a socialist Prime Minister were held during October 1993, amid much rhetoric and international debate over questions of an "independent" Macedonia and minorities in Northern Epirus.

SOCIETAL STRUCTURES AND THE ORIGINS OF AUTHORITARIANISM: A GENERAL ARGUMENT WITH REFERENCE TO THE ARAB WORLD

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This thesis attempts to explain the origins of, and the reasons for the persistence of non-democratic forms of rule in the Arab world. It seeks to define the minimum social prerequisites for the development of democratic institutions, and then shows that in large measure these prerequisites are lacking in Arab societies. Moreover, this deficiency is not the result of Islam or the "Arab Mind," but is primarily a consequence of the socioeconomic structures found in the Arab world. This thesis flows from the general to the specific in first providing an overview of socioeconomic structures, by dividing them into three categories: hunter/gatherers, agrarian and modern industrial. It makes the argument that the socioeconomic structures of modern industrial society generate social circumstances that are far more favorable to the development of democratic political institutions than either the agrarian or the hunter/gatherer. Following this, the thesis looks specifically at the socioeconomic structures of the Arab world, making the argument that, largely as a result of the character of cultural and economic interaction with the West, the societies of the Arab world have maintained their primarily agrarian structure and they are therefore not predisposed toward democratic politics.

DETERMINANTS OF IRAN'S FOREIGN POLICY: THE IMPACT OF SYSTEMIC, DOMESTIC AND IDEOLOGIC FACTORS

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This thesis attempts to explain the origin of state behavior in international politics. It compares the arguments of state level theorists who emphasize the decisive role that internal attributes, including domestic politics, political elite and regime ideology, to that of structuralists, who focus on the decisive impact of the structure of the international system. The difference is crucial: do we examine domestic politics in order to predict state behavior in international affairs or do we assume that any state, given its place in the international system, will act similarly without regard to these internal factors? The case study examined is Iran, from the early 1960s to 1989. During this period, the international system remained bi-polar, dominated by the U.S.-U.S.S.R. rivalry. The internal attributes of Iran changed radically, however, as a result of its 1979 revolution. With such a fundamental shift, state level theorists would expect a radical change in Iranian foreign policy. With the continuity of the international system, structuralists would expect essential continuity in Iran's external behavior. This thesis shows that despite rhetorical changes, Iranian foreign policy remained fundamentally the same under the Shah and the Ayatollah. The structural approach is a more useful guide to understanding state behavior.

WE BOMB, THEREFORE WE ARE: THE EVOLUTION OF TERRORIST GROUP LIFE CYCLES

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The potential for conflict between the United States and terrorist groups is higher than in the recent past. This thesis attempts to understand the underlying causes for the rise and fall of terrorist groups by developing a theory that explains the evolution of their life cycles. This thesis argues that once organizational issues take priority over instrumental ones terrorism becomes self-defeating and survival threatening for the terrorist group. Since this priority shift occurs as a natural consequence of their internal dynamics, the seeds of a terrorist group's destruction exist within the group itself. Factors external to the terrorist group, however, can suppress the germination of those seeds and allow the group to survive. The dynamic interaction of these internal and external influences shapes a terrorist group's life cycle. Understanding the nature of this process is important for the design of counterterrorist policy.

UNDERSTANDING ORGANIZED CRIME GROUPS IN RUSSIA AND THEIR ILLICIT SALE OF WEAPONS AND SENSITIVE MATERIALS

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Through the example of illicit sales of weapons and sensitive materials, this thesis shows how an economic theory of organized crime can be used to understand and predict the behavior of organized crime groups in Russia. The author assumes that organized crime groups are rational, "corporate like" entities, that seek to maximize profits and minimize the risks involved in attaining those profits. Therefore, they assess the opportunities, risks and potential benefits of committing crimes. Furthermore, the assessment is entirely dependent on the condition of the environments in which they must operate. When this theory is applied to Russia, it shows that Russia's political, economic, state security, and social environments are well suited to the illicit sale of weapons and sensitive materials. This is due to the increased opportunities, decreased risks, and huge potential benefits associated with these illicit activities in Russia today. As a result of this analysis, recommendations can be made that will better focus the efforts to fight proliferation by organized crime groups.

THE AMERICAN FACTOR IN THE EVOLUTION OF CHINA'S MARITIME DOCTRINE

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Since the birth of the People's Republic of China (PRC) in 1949, American military strategy, foreign policy, and naval presence in East Asia, have all had significant effect on the evolution of China's naval development, strategy, and maritime doctrine. This thesis will explore the roles, direct and indirect, the United States has played in the development of China's maritime doctrine. China is quickly becoming a regional maritime power and will continue to be a significant factor in the strategic equation of the Western Pacific. The commonly held perception, that China is primarily a continental power, is no longer true as the Chinese navy and merchant marine fleet are today among the largest in the world. As China's national interests expand beyond the Asia-Pacific region, understanding the natural maritime component of those interests will be necessary in the evaluation of China's global aspirations and national strength. This research will be relevant in the assessment of China's maritime doctrine in the 1900s and will allow planners of the Asia-Pacific region to better understand China's often pragmatic approach to naval development and strategy. It will be up to the planners and strategists alike to build on this study and make their own interpretations and applications to policy-making as the future unfolds.

THE NATIONAL INTERESTS OF SINGAPORE: A BACKGROUND STUDY FOR US POLICY

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With the loss of United States bases in the Philippines, the forward presence mission of the US miliary is moving to a new phase. With fiscal restructuring at home and less unity of purpose among the nations of Asia, the United States is moving to a strategy of "places not bases" in Southeast Asia. For the strategy to succeed, it is necessary to find like-minded partners in the region who will allow open access to facilities to provide the support needed for the US military to operate globally. The Republic of Singapore has been a vocal advocate for a continuing presence of United States forces in the Asia-Pacific. In consonance with its views, Singapore has offered the United States military expanded access to its facilities, agreeing to allow the stationing of a limited number of US military personnel in the Republic. It behooves US policy planners to understand the views of the Government of Singapore. This thesis explores institutional development in Singapore, detailing the evolution of its political, economic, diplomatic and defense structures. As a background study, it gives an appreciation of Singapore's view and national interests.

TOWARD THE PROPER APPLICATION OF AIR POWER IN LOW-INTENSITY CONFLICT

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This study argues that the U.S. Air Force's current framework for applying air power, termed the strategic bombing model, is inappropriate for low-intensity conflict (LIC). It outlines this model and traces the application of strategic bombing principles, by American air campaign planners, in every major conflict involving air power since World War II. This study then describes how two characteristics of the LIC environment undermine the strategic bombing model: (1) the vital "center of gravity" in LIC is sociopolitical in nature, it is not embodied in the enemy's leadership element; and (2) the traditional targets for a strategic bombing campaign are too diffuse and abstract within a LIC scenario to be attacked effectively by air power. This study then proposes a framework, for the application of military force in LIC operations, that addresses these aspects of the LIC environment. It outlines the proper role for air power within this framework. This study notes that the effective employment of air power in LIC relies more on the airplane's ability to support ground operations than its capability to carry and drop ordnance.

THEATER MISSILE DEFENSE: BEYOND PATRIOT?

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This thesis examines the major obstacles to development and deployment of effective U.S. Theater Missile Defense (TMD) systems. America is embarked on an aggressive TMD acquisition program with 12 TMD systems under research and development, including the Brilliant Eyes satellite and the Israeli Arrow program. This thesis reviews the effects of ambiguities in the 1972 Anti-Ballistic Missile (ABM) Treaty on TMD development. Current TMD programs are further evaluated to determine if they have the capability to counter strategic ballistic missiles. Other issues examined include the effects of technology advancement on the ABM treaty and TMD, funding restraints of TMD, and the implications for the global arms control structure of an abrogated ABM Treaty. This study concludes that several of America's TMD programs under consideration are capable against strategic ballistic missiles and thereby violate the ABM Treaty.

EGYPTIAN NUCLEAR NONPROLIFERATION: THE POLITICS OF A WEAK STATE

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This thesis uses the available literature regarding Egypt's nuclear development program from 1952 to 1981 to show that a weak state faces insurmountable structural restraints from developing nuclear weapons even if motivation and capability are present. According to international security conditions and initial science development in 1952, Egypt should have acquired nuclear weapons by 1970. Presidents Nasir and Sadat undermined the very Egyptian agencies they created to develop nuclear weapons technology. A state's international security motives and technology development are necessary but not sufficient conditions for nuclear proliferation. The necessary and sufficient condition is that a state be a strong state, able to extract resources from society and able to enact policies which require societal compliance. Weak state leaders cannot resolve the dilemma of opposing domestic security and international security agencies from developing nuclear weapons. United States nuclear nonproliferation policy must consider the political variable of state strength in order to determine the likelihood of proliferation.

TOWARD A NEW STRATEGIC FRAMEWORK:
A UNIFIED COMMAND PLAN FOR THE NEW WORLD ORDER
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Since its origins in the years immediately following the Second World War, the Unified Command Plan (UCP) has evolved through the combined effects of external pressure from strategic planning for a global war the Soviet Union and the internal bureaucratic and doctrinal infighting among the Joint Staff and the various services. This infighting was not merely over service 'turf battles', but also touched the very heart of the individual services' philosophies on command in war. This thesis follows the history of that evolutionary process since World War II with an eye toward a future revision to the UCP. Given the fundamentally altered geo-strategic situation brought about by the collapse of the Soviet Union, the author argues for a complete revision of the UCP based on distinct post-Cold War theater and regional missions. Instead of consolidating the bulk of U.S.-based conventional forces into the U.S. Atlantic Command, the author proposes the retention of several separate (but joint) 'strategic' conventional forces commands based on mission, readiness, and deployability/sustainability criteria.

THE FRENCH POLEMIC: NATIONALISM, RACISM AND ATLANTICISM
IN THE PAST, PRESENT AND FUTURE
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This thesis offers an overview of French nationalism, racism and Atlanticism in the country's past, present and future. It argues that nationalism and racism lie at the root of the French socio-political polemics and that the contemporary problems draw from French history. This explanation places particular emphasis upon the evolution of France as a cohesive nation-state and the subsequent development and definition of the French citizen, as well as the corollary concept of the foreigner. This study also discusses the repercussions of nationalism as exhibited through xenophobic tendencies and racism throughout French history and into the present. The French integration model further explored, reveals nationalist proclivities that intertwine with the assimilation process of immigrants. This thesis seeks to unknot the issues of French nationalism as a basis for better understanding and a more effective U.S. policy with France.

CHANGING ROLES OF THE UNITED STATES AND JAPAN IN THE
SECURITY OF SOUTHEAST ASIA
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Advisor: Claude A. Buss-Department of National Security Affairs

The Hypothesis of this study is that the United States and Japan have important and complementary roles to play in contributing to the peace and stability in Southeast Asia in spite of the end of the Cold War. Historical perspectives with regard to Southeast Asia since the withdrawal of the United States from Vietnam until the end of the Cold War are provided as the foundations for change. The national development of the nations of Southeast Asia, the implications of the rapid economic growth of China, and the military buildup in the region since the end of the Cold War are examined. Similarly, the rising transnational problems of Southeast Asia including piracy, drug abuse, a burgeoning population and environmental issues are addressed. The basic changes in American policies toward the region, including the implications of the withdrawal from the military facilities in the Philippines, and the impact of the reductions in the military budget are examined. Likewise, basic Japanese policies toward Southeast Asia, particularly in light of recent dramatic changes in Japanese internal politics, the effects of the Persian Gulf War, and the Cambodian experience, are discussed.

THE FIFTH ESTATE: THE NEW MEDIA OF DESERT STORM
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This thesis examines how changes in the news media, as evidenced in Desert Storm, have resulted in what the author terms the "new media." These changes in the media are radically altering the conduct of national policy, including war. Subject areas addressed include the new media's impact on intelligence, wartime diplomacy, and public opinion. Additionally, the potential ramifications of the growing multi-national nature of the news media are extensively examined. Specific changes in the media that are also addressed include the real-time coverage of war, the global scope of wartime television coverage, technological advance of the media, and increases in national and global television viewership of wartime coverage. The methodology the author uses is a qualitative examination of the media and its apparent impact during Desert Storm. This thesis concludes with recommendations for DOD/government to confront, manage, and utilize these changes in the media so as to allow the implementation of policies that best serve the national interest. The primary purpose for this work is to spur the government/DOD into addressing the "new media" and considering the concept of an information strategy.

THE GERMAN DEBATE OVER MILITARY PEACEKEEPING MISSIONS: THE FIRST STEP TOWARD AN EVENTUAL COMBAT ROLE
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This study analyzes the steps taken by the German Federal Government to transform the character of German security policy from the customs of forward defense on the inner-German border to the strategic realities of the present. While this author believes quite firmly that the time is drawing near when German soldiers will participate in combat within the framework of collective defense and security in a future conflict, considerable obstacles to such a contingency remain. The study interprets the interaction of the elements of government, the military, political parties and the international system in the transformation of German defense policy since the shock of the Post-Cold War world has overwhelmed Atlantic security institutions. This thesis describes the strategic interaction of how Germany's political leaders have adjusted themselves to an unfamiliar and uncomfortable world of war and peace. In the process, Germany is discarding the security policy of so-called reticence, but what policy will replace it remains unclear.

STORMY WATERS: TECHNOLOGY, SEA CONTROL AND REGIONAL WARFARE
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An important aspect of the current strategic calculus is the diffusion of technology and proliferation of advanced weaponry, particularly naval weapon systems. This is of particular concern for the United States' Navy, historically the first on-scene and the likely target of any initial challenge to our presence. The Navy's new warfighting doctrine, "...From the Sea" focuses the Navy on these challenges. However, it has not been complimented by the necessary recapitalization and procurement to make it truly operational. To bridge the gap between the doctrinal concepts of "...From the Sea" and current capabilities, the Navy must improve its ability to exercise sea control and dominate the littoral battlespace. This will require tough procurement choices and significant investments in mine warfare, advanced military aircraft and state-of-the-art C4I systems. It may also be necessary for the Navy to postpone certain improvements or abandon certain missions in order to refocus and selectively modernize elements of the fleet.

UNITED NATIONS - DIVIDED STATES
PEACEKEEPING IN THE 1990S
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This thesis examines the ability of the United Nations to use military forces to aid in the resolution of intrastate conflict. The end of the Cold War has fostered a new spirit of enthusiasm for the peacekeeping function of the United Nations. This enthusiasm encouraged the view that the deployment of U.N. peacekeeping forces can serve as a panacea for a wide range of conflicts. This includes intrastate conflicts. This new spirit of multilateral activism has nurtured the belief that intervention in the internal conflicts of a state is legitimate and necessary to the peace and security of the world community at large. The purpose of this thesis is not to examine the validity of this claim. The purpose is to examine the ability of the United Nations to carry out this task. This thesis is structured around four chapters. Chapter II surveys the "evolution" of the concept of peacekeeping and new roles assigned to U.N. forces. This chapter also examines an emerging trend in conflict in the late twentieth century - state disintegration. Chapter III investigates the ability of the United Nations to execute these new missions given its inherent limitations as a system of highly diverse political actors. Chapter IV evaluates the problems intrinsic in this new class of mission, such as the efficacy of the use of force and the requirements for the control of large tracts of territory. Chapter V is a case study of the political process as it emerged in the United Nations Transitional Authority in Cambodia (UNTAC). In the final analysis, this thesis contends that the United Nations security apparatus, as it presently exists, is ill-suited to deal with situations as intractable as Cambodia or Somalia.

GERMAN-AMERICAN SECURITY RELATIONS
WITHIN NATO AND THE UN
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The war in the Balkans suggests that despite the end of the East-West conflict, general instability casts a pall of doubt over hopes of enduring peace in Europe and beyond. As one sees in South East Europe, post-communism creates nationalism which can lead to war. The former Yugoslavia is the test case. In East Central Europe, where former Soviet satellites are facing a similar power vacuum and Russian imperialism celebrates its possible rebirth, war could be the consequence if NATO is not able and willing to provide security and stability in this region. This thesis investigates the factors which define the current crisis in NATO and transatlantic security relations. This in turn brings up the question of structural realities in German-American strategic interaction. This thesis examines how lasting internal conflicts gain new explosive force today and presents conclusions regarding the survival of NATO. In the end, the thesis suggests that NATO and the tantamount security partnership with the United States is vitally significant for Germany and for stability in Europe. This maxim applies to the past and it hold equally true for the future.

PRESENCE IN THE LITTORALS - THE COVETTE SOLUTION?
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Forward deployed naval forces are expected to remain the principal military option for underscoring U.S. foreign policy objectives abroad. But as the numbers of deployable ships decline, keeping adequate numbers of U.S. Navy forces deployed will become increasingly difficult. Since no nation possess unlimited resources, determining the correct number, capability, and mix of warships is extremely difficult, if not impossible. As large numbers of expensive combatants become difficult to budget, they become, in a sense perhaps, "irreplaceable", a liability which can outweigh their unparalleled capabilities. Small, 1,500 ton corvettes offer a supplement by way of their ability to apply "appropriate naval force at the decisive point, at the decisive moment." Although combatants are not part of present American naval strategy, this thesis concludes that such corvettes can contribute efficiently to several of the roles and forward presence missions of the future. This conclusion is based on three interrelated factors: national strategy, fiscal constraints, and emerging or anticipated technologies. A flotilla of small combatants would be a complementary supplement to the combatant fleet of 2010, sustaining our tactical advantage and strategic commitment as a world leader. The penalty of building only large and expensive warships could be inadequate numbers for success in war availability in peace.

FROM CONFLICT TO COOPERATION:
THE ON-SITE INSPECTION AGENCY AS A MODEL FOR INTERNATIONAL ARMS CONTROL ORGANIZATIONS
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Advisor: Dana Eyre-Department of National Security Affairs

The major conclusion of this thesis is that the structure of intrusive verification regimes imbedded within internal treaty mechanisms provide incentive for international cooperation.

COCOM AND THE FUTURE OF CONVENTIONAL ARMS EXPORTS IN THE FORMER COMMUNIST BLOC
Eric John von Tersch-Captain, United States Army
B.S., United States Military Academy, 1983
and
Richard Andrew Hove-Captain, United States Army
B.S., Nebraska Wesleyan University, 1984
Master of Arts in National Security Affairs-December 1993
Advisor: Mikhail Tsypkin-Department of National Security Affairs

This thesis describes the realities of the military industry in some of the key countries in the Former Communist Bloc (FCB) and their perspective on the role that military exports plays in their political and economic structures. Furthermore, the thesis asserts that, because of increased transfers of high technology and changing economic imperatives, weapons exports from the FCB pose a potential threat to the United States' ability to exercise political and military options in international affairs. Finally, the thesis proposes a solution to the problem noted above. The thesis argues for a series of changes to the CoCom structure that will combine the particular demands of the evolving FCB states with the realities of the modern world. In doing this, the thesis proposes a new conceptual framework for CoCom as well as specific actions to reduce the deleterious effects of arms sales from the FCB.

UNDERSTANDING THE INTELLIGENCE VALUE OF CELLULAR COMMUNICATIONS IN JTF OPERATIONS (U)

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Michael K. Shields-Department of Electrical & Computer Engineering

Information about cellular communications can make a major contribution to the commander's overall picture of the battlespace in JTF operations. This is especially true today as the use of cellular communications continues to grow rapidly worldwide. The basic concept and technology behind cellular communications, and the specifics of the different analog and digital cellular systems in use today are explained to give the reader a general understanding of cellular communications. Geolocation techniques, including Angle of Arriva (AOA), Time Difference of Arrival (TDOA), and a hybrid method using both AOA and TDOA are also discussed. The remainder of the thesis involves intelligence support to the JTF commander and is illustrated in a scenario. The scenario shows how information about cellular communications can provide support to the JTF commander of a forward deployed Naval expeditionary Force tasked to provide the initial "enabling force" in a joint operation by conducting an amphibious landing, from the sea, in a generic Third World country. The scenario concentrates on Command, Control, and Surveillance; one of the four key operational capabilities which determine the success of NEF operations, as explained in the 1992 Navy white paper "From the Sea."

THE EVOLUTION OF CIVIL-MILITARY RELATIONS IN VIETNAM

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The mere mention of the name "Vietnam" conjures up a multitude of conflicting images and emotions in the hearts and minds of individual Americans. The current move toward a normalization of diplomatic relations between the United States and the Socialist Republic of Vietnam (SRV) demands a new perspective be taken on this traditional ambivalence. By exploring the geographical, cultural, and historical development of political and military organizations in Vietnam, this thesis goes beyond the focus of most sociological models that begin their examination of civil-military relations in Vietnam with the Communist lead revolution of 1945. One such model, that of the Revolutionary Professional Soldier, is used by this author to examine the evolutionary nature of civil-military relations in Vietnam, from their earliest manifestations during the colonial period to the present.

WOMEN, RAPE AND WAR: GAINING REDRESS WITHIN HUMAN RIGHTS FRAMEWORK

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The evolution of human rights and the world women's movement have combined for the first time to place rape as an instrument of war on the agenda of international politics. Rape in war has been regarded as an incidental and individual violation of military law. It has rarely been given scholarly consideration, not even by historians of war, except to glorify it as a form of propaganda. This thesis will examine: (1) how the historical subordination of women in peacetime is related to the wartime rape of women, (2) the manner in which the mass rapes in the Bosnian War were brought to the world attention and onto the agenda of international human rights and (3) the impact of the feminist movement in the United States in redefining the way sexual assault and rape are understood in our culture.

BLAME-PROOF POLICYMAKING: CONGRESS AND BASE CLOSURES

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In contrast to the current political science literature on Congress, this thesis argues that the reelectability of Congressmen is not damaged when military bases in their districts are closed. According to Mayhew, Lindsay, and other scholars, members of Congress must prevent their bases from being closed or face "great electoral jeopardy". Nevertheless, beginning in 1987, legislators created a process that was designed to facilitate base closures. Why would they engage in such apparently suicidal behavior? Have voters actually punished the legislators that suffered base closures in their districts, as Mayhew and others would predict? After examining the congressional election returns from 1990 and 1992, which followed the base closure rounds of 1989 and 1991, respectively, this thesis found that base closure has no effect on the reelectability of members of Congress. What accounts for this finding? Although bases often do provide important economic benefits for congressional districts, and would therefore be expected to be of critical concern to voters, Congress designed a base closure system that insulated legislators from blame if bases were closed in their own districts. The success of this "blame-proof" system has important implications for the future of the base closing process and the larger question of how, and under what circumstances, Congress delegates power to the President.

REVOLUTION OR REALISM?
UNITED STATES-IRAN RELATIONS IN THE POST-COLD WAR ERA

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The end of the Cold War has caused the emergence of regional conflicts and a lack of focus in United States foreign policy. This situation has resulted in a newly confrontational stance with Tehran, manifested by an American policy of containment of the Islamic Republic. However, this portrayal of Iran as a pervasive threat to American interests is a mistake. This study offers an historical analysis of Iran's foreign policy interests and strategic outlook, a discussion of the dynamics of the Islamic Republic, and a history of United States-Iran relations. Strategic concerns have always dominated this relationship and this continues to be so today. With the Soviet collapse and the defeat of Iraq, an altered and delicate balance of power exists in Southwest Asia. Iran's strategic importance has thus increased. Furthermore, Tehran must pursue moderation for a variety of reasons. The author concludes that the United States and Iran share both strategic and economic interests. America should pursue these shared interests from its current position of strength and gain Iran's cooperation on important issues. United States engagement with Iran would strengthen the pragmatic elements in the government, foster economic development and improve the security and stability of the region.

ALGERIA IN TRANSITION: THE ISLAMIC THREAT AND GOVERNMENT DEBT

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Algeria's current political crisis serves as a reminder of the fragility of attempts to reform governments in search of "democracy". Algeria experienced two rounds of multi-party elections in 1990 and 1991. Broad-based political participation may indicate "fast-track" democracy, but questions about the feasibility of political Islam clashes with traditional notions of democracy. This thesis will argue that Algeria's decision for a political opening was due to social pressures and exacerbated by economic difficulties posed by falling oil prices rather than motivated solely by political reform rationale. The events leading up to the riots and subsequent reforms will support this argument. Additionally, U.S. and regional policy implications will be examined.

THE EMERGENCE OF ECONOMIC TRADING BLOCS: THE ROLE OF JAPAN AND THE IMPLICATIONS FOR LATIN AMERICA

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With the emergence of regional economic blocs, the focus has shifted to recent economic development in the Latin American region. This thesis addresses the question of Japan's economic influence in the region and the implications for Latin America's economic future. It is argued that Japan's strategy in the region is based upon economic needs and the importance of securing a position in the regional economic development and potential Americas trading bloc. It is proven by using an analysis of economic relationships and trade patterns used by Japan in Asia compared to current Japanese economic activities in Latin America. Major findings include Japan's strategy is situational on targeted countries for either raw material access and/or Western Hemisphere market access.

MASTER OF SCIENCE
IN
OPERATIONS RESEARCH

CURRENT ISSUES CONCERNING RELIABILITY ESTIMATION IN OPERATIONAL TEST AND EVALUATION

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There are several perennial issues concerning reliability estimation in Operational Testing and Evaluation (OT&E). Two of these include, "how should one model the underlying failure distribution of a continuous-time system," and "how can a testing agency use information from DT in order to reduce OT resource requirements." In the former issue, some OT&E analysts have questioned whether or not the exponential failure distribution should be used in all cases for continuous-time systems, and have suggested Weibull distribution as an alternative in some instances. In the latter, the notion of combining DT and OT data has been an anathema to those involved in OT&E, however, with ever-tightening military budgets, it may be time to revisit the issue. First, this thesis compares the exponential and Weibull failure distributions in terms of the amount of test time needed to demonstrate, to a given level of confidence, that the true MTTF of a system is at least as large as the minimum acceptable value, and also in terms of the actual confidence level associated with the lower confidence level procedure when the system has an increasing (or decreasing) failure rate function. Second, the thesis examines the behavior of an estimator for the relationship between DT and OT failure data using a Monte Carlo simulation. Finally, the thesis introduces a hierarchical Bayes approach for the estimation of the relationship between DT and OT failure data when a gamma prior distribution is assumed.

MINES IN THE SURF ZONE: A PROPOSED BREACHING CONCEPT

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This thesis addresses the threat that mines in the surf zone (ten foot curve to the high water mark) pose to Operational Maneuver from the Sea. Additionally, problems presented by minefields beginning at the high water mark and extending inland are reviewed. Effectiveness of notional minefields consisting of tilt rod and pressure fused anti-tank mines are modeled as a planar Poisson process. The delivery of the assault echelon (a Marine Expeditionary Force (Forward)) by landing craft is modeled as a simple circular flow process. Three methods for overcoming the minefields are developed and compared using five measures of effectiveness. A decision criteria for breaching a minefield by bulling through is offered. A breaching concept using fuel air explosives and a unique mine rake are presented. The thesis concludes that development of the "Blast, Rake, Breach" concept should be pursued.

APPROXIMATE MODELS FOR THE PROBABILITY DISTRIBUTIONS FOR INVENTORY POSITION AND NET INVENTORY FOR NAVY REPAIRABLE ITEMS

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This thesis represents the most recent step in the development of a new wholesale level repairable item inventory model for the Navy. Distinguishing features of the process by which repairable items are managed in the Navy are batching of both repair and procurement orders and a specific repair assessment policy which sees repairable items enter repair agencies in batches but leave as single items. Approximate steady state probability distributions for inventory position and net inventory are developed and these are extensively tested against simulation results. Graphical analysis and testing using nonparametric methods suggest that the approximations developed closely resemble the distributions obtained via simulation.

MARITIME PREPOSITIONING FORCE (MPF) THROUGHPUT ANALYSIS OF A MARINE EXPEDITIONARY UNIT (MEU) SLICE OFFLOAD

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This thesis describes the design and employment of a general transportation and distribution simulation toolbox and an extension to the toolbox used to model the instream offload of a Marine Expeditionary Unit (MEU) Slice of a Maritime Prepositioning Force (MPF). The Simulated Mobility Modeling and Analysis Toolbox (SMMAT) is a toolbox of object oriented modules written in MODSIM II® by faculty and students, including the author, of the Naval Postgraduate School for transportation and distribution modeling. The MEU Slice offload model is built as an extension to SMMAT, with itself being easily extendible to model other aspects of MPF operations. The objective of this thesis was twofold, (1) to build SMMAT and demonstrate its feasibility as a toolbox, and (2) to determine which of four asset distribution setups ashore, at varying levels of equipment reliability, will allow for the fastest offload and throughput of the MEU slice. This thesis successfully demonstrated in SMMAT's usefulness as a transportation and distribution simulation toolbox, and the MEU Slice study indicates that no one distribution setup ashore is statistically faster than any other one.

FINDING AN OPTIMAL PATH THROUGH A MAPPED MINEFIELD

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An integer programming model is developed to find an optimal path through a naval minefield which has been completely mapped. The region of the minefield is discretized into a grid network and an network flow model with side constraints is created to minimize the sum of a weighted combination of risk and distance along any path through the minefield. Tests are conducted on a 20 X 20 grid with a field of 10 mines. This generates a model with 1470 variables and 818 constraints which is solved on an 80386 33MHZ PC in 405 seconds. Tests are run for various weights and to test the effects of shifting the grid in space. Results show that varying the weight yields paths with sensible tradeoffs between distance and risk, and show that improved paths can be obtained by shifting the network grid. The model developed provides users with a means to plan a covert penetration of a minefield using the potential intelligence-gathering capabilities of an autonomous underwater vehicle.

MODELING JOINT THEATER LEVEL OPERATIONS IN THE EARLY ENTRY THEATER LEVEL MODEL

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This thesis investigates the capabilities of the Early Entry Theater Level Model (EETLM), a modified version of the Future Theater Level Model. It incorporates joint theater level operations within a dynamic decision making framework and a stochastic environment. This thesis includes a rationale of why a stochastic joint theater model is needed, a detailed description of the model's basic operations, and the enhancements and modifications which are required to incorporate joint operations. The development of measures of effectiveness, and their subsequent analysis, focus on the unique perception-based capabilities of EETLM and its ability to provide new insights to joint task force commanders. The analysis focuses on alternative force level/time combinations and their resultant differences in outcomes. Where results appeared counterintuitive, further investigations were conducted. These areas were either analyzed and documented or followed by brief descriptions of required future work for EETLM. EETLM successfully demonstrated its capability to incorporate joint theater level operations, however, the analysis indicates that some of the rudimentary algorithms and the current computational platform are limiting EETLMS's capabilities.

MODELING ALTERNATIVE REALIGNMENT AND CLOSURE CONFIGURATIONS FOR NAVAL AIR STATIONS

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This thesis develops a bi-criteria integer programming model with the objectives of maximizing pilot training rate and minimizing station operating costs to assist the Navy in the generation of alternative realignment. Realignment of six missions are considered among five training air stations using 1993 data submissions to the Presidentially appointed Base Realignment and Closure Committee. The ability to vary key model inputs without obtaining a widely varying output provides decision makers with conclusive evidence concerning optimal squadron realignment and base closure. Given the BRAC 1993 cost structure and model in place with the exclusion of other considerations which may have been relevant, Naval Air Station Corpus Christi should be considered for closure by 1998 to achieve an average annual savings of $10 million. The one-time cost of $160 mission would be paid back over 16 years.

VALIDATION AND JUSTIFICATION OF THE USE OF A SALES-APTITUDE TEST FOR US ARMY RECRUITER SELECTION

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In this thesis, statistical and cost/benefit analyses are used to validate and justify the use of a sales-aptitude test for selection of successful recruiters. Using samples of experienced recruiters, with historical records of mission achievement, a recruiter's successfulness/unsuccessfulness was evaluated by pre-determined Measures of Recruiter Effectiveness. After grouping recruiters based on time served as a recruiter, several sales-aptitude tests were performed to determine the effectiveness of the sales-aptitude test in predicting, and distinguishing between, successful and unsuccessful recruiters. Additionally, sales-aptitude test score data was obtained on a control group of non-recruiters. Using this data, in conjunction with that of experienced recruiters, several more statistical hypothesis tests were used to determine if the test can be used to screen those candidate recruiters who can successfully complete the Army Recruiter Course. Based on findings that the selected sales-aptitude test could only be used as a screening device in the recruiter selection process, and not to predict recruiter success in the field, a nonexhaustive cost/benefit analysis was performed to justify the use of the test in a screening role. The cost/benefit analysis indicated that the selected sales-aptitude test, used in a screening role, could save the US Army Recruiting Command and the US Army anywhere from an approximate minimum of $500,000 to an approximate maximum of $5,000,000 annually.

HEAVY FORCE ANALYSIS OF JAVELIN

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Present mission requirement and increased weapons technology dictate that there is a need to replace the US Army Infantry's medium antiarmor Dragon weapon system. In lieu of the Dragon, the US Army is opting to field a new system called the Javelin Antitank Weapon System. This thesis explores the potential for the Javeline to enhance the operational effectiveness of the Mechanized Infantry assets of the US Army. This analysis includes the development of Mechanized Infantry scenarios which employ the Janus(A) high resolution combat model. These scenarios model force-on-force trials of mechanized versus fully modernized armor heavy threats in deliberate defense and movement to contact missions. Results of the experimental data analysis indicate that the Javelin performs superior to the Dragon in terms of the mechanized force's range of antiarmor engagements, lethality, target stealing, and survivability. The findings to this thesis could benefit the US Army inforce structure and antiarmor weapon requirements with the future fielding of the Javelin to Mechanized Infantry units.

MODELING CONTROL IN COMPUTER SIMULATIONS

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This study outlines the design, implementation, and testing of the General Control Model as applied to the Future Theater-Level Model (FTLM) for the control of Joint and Allied Forces for all operational sides. The study develops a notion of battlefield control and describes the characteristics necessary to represent this notion of control in a computer simulation. Central to the implementation of the General Control Model is the robust capability for the user-analyst to describe any control relationship of research interest and to do so without having to alter the programming code. The user-analyst is provided the capability to determine the cause and effect relationship of different control representations in a simulation. A full description of the model is complimented by an explanation of the implementation to facilitate the use of the General Control Model. A discussion of the initial test results leads to a more rigorous test which confirms the intended behavior of the general Control Model in FTLM. Lastly, recommendations for future improvements to the General Control Model and FTLM are outlined to assist future research endeavors.

TARGET MOTION ANALYSIS FROM A DIESEL SUBMARINE'S PERSPECTIVE

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The subject of this thesis is diesel submarine tactics for performing an effective Bearing-only Target Motion Analysis while approaching a surface target, given the submarine's limited speed and battery endurance. The research is conducted through a Monte Carlo simulation. Each replication simulates a submarines's approach, attack and eventual torpedo release, to determine the success or failure of the attack. The number of successful attacks in every replication is a measure of effectiveness of the particular tactics employed. The simulation shows that a modern diesel submarine is capable of conducting a Bearing-only TMA while at the same time approaching a surface agent.

ENHANCED AIR TASKING ORDER OPTIMIZATION MODEL

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This thesis is an enhancement to the Air Tasking Order (ATO) Optimization Model, a linear integer optimization model that seeks to match the best air assets against the highest priority targets. The ATO Optimization Model was written as a 1993 Master's Thesis to help the Joint Forces Air Component Commander in wargames rapidly produce an ATO. The model was used in the global wargame SEACON 93 but some difficulties were encountered. Asset utilization was restricted by the static structure of the model and attempts to coerce the model into doing dynamic scheduling were unsuccessful. Additionally, the model's implementation required the user to have unrealistically extensive knowledge of the software being used, DBASE IV and GAMS. This thesis addresses these difficulties. First, it explicitly incorporates the time dimension in the optimization model, thereby allowing multiple sorties per aircraft per day, something that was not allowed in the static model. Second, a graphical user interface has been built around the optimization model to alleviate the need for the user to have a strong background in database or optimization software. The enhanced model produces face-valid, results that are readily usable within high-pressure, fast-paced environments, such as a global wargame.

COMPARISON OF FIXED WING AIRCRAFT ALGORITHMS FOR JANUS

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This research compares the fixed wing altitude algorithms utilized in the United States and the Australian versions of the combat modeling tool, JANUS(A). The Australian Army Battle Simulation Group has recently developed a new algorithm that more realistically models aircraft flight profiles within JANUS(A). The Australian Army Battle Simulation Group has recently developed a new algorithm that more realistically models aircraft flight profiles within JANUS(A). A Low-High-Low strike profile was simulated, using both algorithms, against low level, littoral anti-aircraft weaponry. The simulated aircraft were flown in a weapons hold environment and number of detections were recorded over the entire strike route as the principal MOE. The simulated aircraft were then subjected to a weapons free environment where engagement data was compiled. The Australian algorithm enabled the operator to alter aircraft altitude and speed during the simulation on command. The ability to alter altitude and speed are essential to accurately modelling tactical evasive maneuvers. These alterations are not features incorporated in the present U.S. version of JANUS(A). Analysis indicates this controllability not only reduced the number of detections significantly, but also increased aircraft survivability within the strike environment. Both of these phenomenon are expected outcomes of such evasive actions. This work also provided the basis for future work that could incorporate virtual simulation with JANUS(A).

NATO MARITIME FUEL DEPOT STRATEGIC PLANNING

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As U.S. and NATO military force levels decline, NATO's maritime fuel support infrastructure is being studies for resizing opportunities. Supreme Allied Command Atlantic (SACLANT) is interested in closing excess depots, if any, while maintaining the ability to support NATO maritime forces. In that the location of a potential crisis where a NATO maritime force may respond is not known with certainty, SACLANT's "facility location problem" is modeled as a multi-period stochastic integer program. The objective of the NATO Depot Location (NDL) problem is to select fuel depots which minimize both the probability and expected amount of a fuel shortage when a NATO maritime force is deployed in response to a crisis. The NDL problem considers shuttle oiler transit distance, days of supply requirements, and NATO maritime force fuel consumption rates. Solving the NDL problem is simplified by the use of a specially constructed graphical user interface, *NATOPOL*. NATOPOL allows the general user to solve the mathematical program and modified problem parameters with ease. Aided by NATOPOL, the user can analyze the effect of logistic policy decisions on the probability and expected amount of fuel shortages. The NATOPOL/NDL model can be used to support long-range planning and feasibility to determine the efficient number and location of maritime fuel depots required to support combatant forces.

OPTIMAL DEPLOYMENT ANGLES FOR THE AIR-DROPPED UNDERSEA WARFARE CABLE IN SHALLOW WATER

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The Advanced Air Deployable Array (AdDA) is an air-dropped undersea warfare device for detection of an enemy submarine in the shallow waters region. Previous studies have introduced six tactical deployment methods by C-130 aircraft. This thesis addresses one of the methods, called "Bound the Expanding Farthest-On Circle." Changes in deployment rules are suggested, and feasibility conditions identified. A model is developed showing how the isolation area where the submarine is to be contained, and the number of needed array segments, can be reduced. Also, as the main work of this study, the effective deployment angles for successive AdDA cable are determined for C-130 pilots. Today these cables, because of their advantages and great utility, can give unique solutions in shallow water tactical operations.

DETERMINING OPTIMAL LOCATIONS FOR NAVY MEDICAL HOSPITALS: AN INTEGER PROGRAMMING APPROACH

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The downsizing of military forces in the 1990's forces Navy Medicine to consider closure and realignment of its hospitals and clinics. Any major Department of Defense (DOD) closure or realignment must be decided according to Title XXIX of United States Public Law 101-510, the Defense Base Closure and Realignment Ac of 1990 as amended. In 1991 and 1993, this act allowed the closure and realignment of numerous Naval installations. In 1995 (the last round of closures and realignments provided for by that law), Navy Medicine expects to undergo a significant restructuring of its hospitals. Through these hospital and civilian providers the Navy cares for assigned active duty, active duty dependents and retiree beneficiaries from all services. This thesis develops an integer linear program, Hospital Efficient Location Program (HELP), which enables Navy Medicine to determine which of its hospital to consider for closure. Using resource and demand data available from standard DOD medical information systems, HELP has identified $0.52 billion annually in potential savings from the closure of seven hospitals by 1999. At this savings, demand for all assigned beneficiaries is satisfied with Naval hospitals providing care for over 95% of active duty inpatient and outpatient demand.

A COORDINATION POLICY FOR THE NATO SEASPARROW MISSILE AND THE ROLLING AIRFRAME MISSILE USING DYNAMIC PROGRAMMING

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This thesis develops a dynamic program, the SEASPARROW Coordinated Assignment Model (SCAM), that determines the optimal coordinated assignment policy for the SEASPARROW missile in a shipboard self defense weapon configuration consisting of the NATO SEASPARROW Missile System, the Rolling Airframe Missile and the Phalanx Close-In Weapon System. Threat scenarios are described by the type of anti-ship cruise missile, the number of threat missiles, the total duration of the arrival window and the relative spacing of targets within the threat stream. SCAM reveals that under various threat configurations it is often advantageous to fire the SEASPARROW at groups of threats in the target stream, rather than always engaging the nearest threat, and further that this policy is robust for a large set of threat scenarios.

FAILURE ANALYSIS OF A REPAIRABLE SYSTEM: THE CASE STUDY OF A CAM-DRIVEN RECIPROCATING PUMP

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This thesis supplies a statistical and economic tool for analysis of the failure characteristics of one typical piece of equipment under evaluation: a cam-driven reciprocating pump used in the submarine's distillation system. Comprehensive statistical techniques and parametric modeling are employed to identify and quantify pump failure characteristics. Specific areas of attention include: the derivation of an optimal maximum replacement interval based on costs, an evaluation of the mission reliability for the pump as a function of pump age, and a calculation of the expected times between failures. The purpose of this analysis is to evaluate current maintenance practices of time-based replacement and examine the consequences of different replacement intervals in terms of costs and mission reliability. Tradeoffs exist between cost savings and system reliability that must be fully understood prior to making any policy decisions.

EFFICIENT USE OF TELEPHONE SURVEY RESPONSE FACILITIES: A DECISION AID

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This thesis develops an object-oriented simulation model of the Computer Aided Telephone Inquiry (CATI) system currently employed by the Defense Health Resources Study Center, which allows recipients of mailed survey questionnaires to respond to the mailed questionnaires via telephone. The simulation models system performance and the response arrival process a transitory queuing system. The primary focus of this study is to develop a predictive decision aid for effective and efficient employment of the CATI system, while minimizing response attrition due to system overload. Sensitivity analysis is conducted to determine arrival rates which overload the system, mean service time effect on system capacity, and effects of various retry decision processes (i.e., the arrival process for respondents who fail to access the system because of system overload). Additionally, possible network optimizations designed to aid in the development of appropriate mailing strategies are discussed. As a predictive tool, the model appears to be quite accurate. Network optimization solutions for mailing strategies may achieve a significantly lower caller attrition rates than strategies which call for evenly distributed batch survey mailings.

AN OPTIMIZATION MODEL FOR SCHEDULING ARMY BASE REALIGNMENT AND CLOSURE ACTIONS

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The United States Army is reducing and reshaping its force structure to adapt to the nation's changing defense needs and budget constraints. Along with significant personnel reductions, the Army is divesting itself of excess infrastructure through a process of Base Realignment and Closure (BRAC). This thesis develops a mixed integer linear programming model to assist The Army Base Study (TABS), the primary analysis agency for Army BRAC issues, schedule BRAC actions for slated closures and realignments. The model generates an optimal schedule which attains maximum potential savings within budgetary constraints. In the past, Army analysts have accomplished this scheduling using a time consuming process with no guarantee of optimality. Using a systematic time efficient approach, the model achieved a 34% increase in savings over the manual schedule developed by TABS for an actual BRAC 93 scenario.

COMPARISON OF OPERATIONAL AVAILABILITY MODELING BY TIGER AND SESAME

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The Department of Defense (DoD) has begun to consolidate the services' similar logistic methodologies. The Joint Logistics Systems Center (JLSC) at Wright-Patterson Air Force Base in Ohio has been tasked by DoD with providing a supply support requirements computation system based on weapon system availability (i.e., readiness based sparing). JLSC canvassed DoD for the different requirements determination approaches used by the services. The Army's Selective Stockage for Availability Multi-Echelon Model (SESAME) and the Naval Sea Systems Command's (NAVSEA) model named TIGER were two applications found to be used in DoD for computing supply support requirements based on readiness sparing (RBS) concepts. This thesis compares TIGER and SESAME, focusing on their methodology for computing the steady-state operational availability for a weapon system for various supply support scenarios. SESAME allows for a four-echelon supply support system and computes operational availability for a weapon system at many locations. At present, TIGER allows for only two echelons of supply support and computes operational availability for a weapon system at only one location.

INTEGRATION OF NAVAL FORCES INTO THE EARLY ENTRY THEATER LEVEL MODEL (EETLM)

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The purpose of this thesis is to demonstrate, in principle, that the Early Entry Theater Level Model (EETLM) has potential for future use as a theater combat model. EETLM is a direct descendant of the Future Theater Level Model (FLTM) developed under the direction of the Joint Staff (J-8, the Conventional Forces Analysis stochastic vice deterministic model, EETLM focuses on the joint aspect of theater combat operations, with particular emphasis on the effect that the early entry of Naval and Maritime Prepositioning Ships (MPS) has on the outcome of North Korean MRC scenario. EETLM utilizes Bayesian update procedures to imitate a level of uncertainty that is characterized by the "fog of war" and is commonplace in modern military operations. Utilizing a notional order of battle for both Blue and Red forces (ground, air and naval), multiple scenarios runs were performed utilizing three possible courses of action for both Red and Blue, and three potential entry cases for Blue: entry prior to the outbreak of hostilities, entry after the outbreak of hostilities, and entry at the time of hostilities. Utilizing a variety of measures of effectiveness, EETLM demonstrated that it does indeed have potential for future use in theater campaign analysis and planning once it has reached developmental maturity.

A COMPUTER-ASSISTED FINAL EXAMINATION SCHEDULING SYSTEM FOR THE NAVAL POSTGRADUATE SCHOOL

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Master of Science in Operations Research-March 1994
Advisor: Gordon H. Bradley-Department of Operations Research

This thesis designs, develops and tests a computer-assisted system to construct final examination schedules at the Naval Postgraduate School. The system is based on a greedy heuristic that produces high quality solutions for 200 examinations in a few minutes on a personal computer. Comparisons between computer constructed schedules and the manual schedule for the 1994 winter quarter show the manual schedule's superiority. Despite this observation, the computer system's ability to rapidly produce feasible schedules (approximately 15 minutes compared to 5 days) makes it ideal to assist the schedulers and to conduct policy studies. One policy study conducted in this thesis shows a reduction in classrooms reserved solely for final exams has little impact on the quality of the schedule. Another policy study shows the difficulty of finding any schedule without some students having back-to-back examinations.

IMPROVEMENTS TO A SURGE AND SUSTAINMENT MODEL FOR WARGAMING

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This thesis documents the design, validation and demonstration of an improved Surge and Sustainment Simulation for wargaming. The model is an object orientated, discrete event simulation written in the Modsim II programming language. The objective is to improve upon an already existing model through logic refinement, and the addition of objects designed to enhance user access to logistics system performance information. The finished product is an interactive simulation model designed to be used as a tool at Service wargaming facilities. Most notable is the model's ability to interact with the user in time steps versus only once at the beginning like other models currently being used in the area of force surge and sustainment.

A COST-LOSS RATIO MODEL FOR HURRICANE SORTIE DECISIONS

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This thesis examines, using the framework of a cost-loss ratio, the dilemma of the Navy decision maker faced with the question of whether or not to sortie ocean-going ships from a port threatened by a hurricane. The long leadtime needed to execute a full sortie requires the decision maker to rely on hurricane forecasts that may contain large errors, despite improvements in forecasting over the past two decades. Furthermore, decision makers may have difficulty interpreting forecasts without the use of a decision aid. Analysis includes interviews with several tropical cyclone experts, a literature review of the economics of hurricanes, and a critique of a number of hurricane decision aids. Based upon this research, this thesis concludes that the CHARM model for setting hurricane readiness conditions is currently the best decision aid available for reducing the number of unnecessary sorties without putting the fleet at significantly increased risk.

TIMETABLING COURSES AT THE NAVAL POSTGRADUATE SCHOOL

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The Naval Postgraduate School (NPS) course schedulers use a time-consuming manual process to assign courses, students, and professors to classrooms. The 1994 NPS Winter Quarter had approximately 535 courses, 953 student-groups, and 230 faculty members assigned to approximately 100 classrooms. This thesis formulates the NPS course timetabling problem as a mixed integer linear problem and develops a Lagrangean relaxation based heuristic to assist the schedulers. the heuristic requires approximately 15 IBM/RISC/6000 model 590 CPU hours to obtain a timetable for the 1994 Winter Quarter (compared to 6 weeks for the equivalent manual exercise). Results indicate that the heuristic can be used successfully to support the study of policy questions. Studies conducted in this thesis show the effect of decreasing classrooms and both increasing and decreasing the number students.

DESIGN OF A PREDICTIVE RECRUITER SUCCESS MODEL (PRiSM)

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Master of Science in Operations Research-September 1994
Advisors: James G. Taylor-Department of Operations Research and
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This thesis describes the formulation and validation of a multiple linear regression model that predicts recruiter success rates. The model's primary purpose is to improve the recruiter selection process by helping to reduce recruiter reliefs. Using recorded information on over 400 members of two active-duty recruiting battalions together with the results of an administered sales ability test, a database was constructed for use in regression analyses. Recruiter success was defined as the response variable in specific, quantifiable terms. Potential predictive variables were identified to reflect the ideal traits of a successful recruiter. The method of Mallow's Coefficient C_p, in conjunction with hypothesis tests, was used to develop the final predictive model. Residual analyses, data-splitting, and cross-validation methods assured the appropriateness and adequacy of the final model to describe and predict recruiter success. However, this model is limited by the fact that all sales ability data was collected using the "present-employee" method. For the purpose of calculation potential cost savings, an analysis using the Taylor and Russell tables was conducted. Cost savings expected from use of the model amounted to nearly $3.38 million annually.

A MULTI-COMMODITY NETWORK DESIGN FOR THE DEFENSE LOGISTICS AGENCY

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The Defense Logistics Agency (DLA) currently operates 28 depots in the United States from which it supplies over 45,000 customers with over 3 million products procured from over 10,000 suppliers. DLA plans to reduce its infrastructure and proposes to analyze its distribution system using the Strategic Analysis of Integrated Logistics Systems (SAILS) model - a mixed integer linear programming model widely used by civilian organizations to make facility location and logistics network design decisions. The size of DLA's distribution system precludes directly evaluating all possible depot, product, and customer combinations. This thesis derives a 29 product, 113 customer aggregation scheme which facilitates SAILS execution and appears to adequately capture sufficient detail to accurately model DLA. Extensive comparisons between this aggregation scheme and others (44-, 49-, and 67-product; and 199- and 113-customer aggregations) at 100, 90, 80, 50, and 30 percent of derived depot throughput capacity show solutions to different aggregations result in virtually identical closure recommendations and total annual cost. This thesis shows how DLA can save over 300 million dollars annually through depot closure and reorganization.

VERTICAL LAUNCH SYSTEM LOADOUT MODEL

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This thesis develops a model to assist in determining the surface-to-air missile (SAM) requirement for defensive firepower in a specific theater. Through the vehicles of simulation, combat and mathematical modeling we determine (1) SAM requirement for theater Air Warfare (AAW) defensive firepower, (2) Aegis equipped Vertical Launch System (VLS) battle force structure for anti-ship cruise missile (ASCM) defense, (3) Aegis equipped VLS ship loadout for AAW defense in a specific theater of operation. The model was used against a mock threat potential consisting of 60 attack aircraft, 150 air launched ASCM's, 100 land launched ASCM's, and 40 surface launched in the original inventory. Two cases were considered: (1) Combat Air Patrol (CAP) available to the battle force and (2) no CAP available to the battle force. In the first case, the battle force required 196 long-range SAM and five Aegis equipped VLS ships with 40 SAM each. In the second case, the battle force required 352 long-range SAM, ten Aegis equipped VLS ships with 36 SAM each.

VALIDATION OF AN ACTIVE MULTIMEDIA COURSEWARE PACKAGE FOR THE INTEGRATED DAMAGE CONTROL TRAINING TECHNOLOGY (IDCTT) TRAINER

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This paper reports the test and evaluation results of the Integrated Damage Control Training Technology (IDCTT) Trainer. This device - the product of a four year advanced development effort - uses interactive courseware which incorporates the latest multi-media computer technology to create a realistic damage control training environment. The trainer was developed to support a recent change in shipboard damage control philosophy called Total Ship Survivability (TSS); a concept which emphasizes the simultaneous repairing of a ship's combat damage while maintaining its ability to fight. The new trainer was comprehensively evaluated using performance data and survey results collected from students and instructors during a three month test period at the Surface Warfare Officer School's Damage Control School in Newport, RI. Findings from seven different surveys are presented: performance comparisons between the conventional trainer and this new trainer are examined; and narrative accounts of both students and instructors are reported. The data clearly identify and isolate the specific benefits as well as some of drawbacks associated with the various enabling technologies integrated during the advanced development of the prototype. Recommendations about operationally deploying the device are discussed and the implications of suggested enhancements are explored.

QUANTIFYING THE VALUE OF RECONNAISSANCE USING LANCHESTERIAN TYPE EQUATIONS

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This paper presents a method to quantify the value of reconnaissance for both direct and indirect fire weapons for the defense-in-sector battle scenario. The Lanchester area fire model and the Helmbold equations were modified to allow the lethality of the defending blue force to be increased as they gained more combat intelligence about the attacking red force, thus modeling intelligence as a true combat multiplier. By adjustments made to parameters in the model, the lethality of blue direct and indirect fire weapons could be adjusted based on the quantity and quality of their intelligence assets. With information from a computer database, and the COMAN model, maximum likelihood attrition rate estimates were calculated for both red and blue forces for then heavy defensive battles conducted at the Army's National Training Center. In each battle, the red force attrition rate was fitted to a curve which represented here by the square law. Using this model in a combat simulation, and with some preliminary work with comparable systems, one could implement a change in blue's intelligence assets and then provide a quantitative measure of the effect that this had on the outcome of a battle.

AIR CUSHIONED LANDING CRAFT (LCAC) BASED SHIP TO SHORE MOVEMENT SIMULATION: A DECISION AID FOR THE AMPHIBIOUS COMMANDER. A (SMMAT) APPLICATION

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Amphibious forces "...From the Sea," are the enabling force of choice to, globally project rapid and sustainable combat power in the littoral. Whether delivering supplies and equipment for military operations or for humanitarian or disaster relief, the Air Cushioned Landing Craft (LCAC), is the primary surface ship-to-shore movement craft. The time needed to transfer the forces ashore may be critical to operational success and is an important planning consideration. Many factors complicate accurate prediction of this time. Even so, various commanders must use the best available information given mission priorities, and resource and capability limitations, to make numerous tradeoff decisions in planning and executing the movement of forces. In this paper, a simulation toolbox, the Simulated Mobility Modelling and Analysis Toolbox (SMMAT) is introduced, and a robust LCAS ship-to-shore simulation model is developed as an extension to SMMAT. This model provides the commander a prediction and tradeoff analysis tool for planning and executing the projection of power ashore.

STRATEGIC AIRLIFT ASSETS OPTIMIZATION MODEL

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Despite the outcome of Operation Desert Shield/Storm, post-operation analysis revealed a shortcoming in USAF airlift capability. The analysis showed that early presence was not sustainable and an early Iraq attack could have inflicted more coalition casualties. This finding prompted Congress to sponsor the Mobility Requirement Study (MRS). This thesis, sponsored by the USAF Studies and Analyses Agency, is an outgrowth of USAF and Joint Staff work for MRS. the thesis develops a multi-period Strategic Airlift Assets Optimization model using linear programming (LP), implemented with the general Algebraic Modelling System (GAMS). The model minimizes late deliveries, subject to constraints such as aircraft utilization rate and aircraft handling capacity of an airfield. This thesis demonstrates that such an LP model has sufficiently fast response time to be a viable planning tool in today's political environment, where major regional conflicts can emerge very quickly. The model can lend support to the study of military options at the planning and acquisition stages, as well as enable planners to quickly assess the impact of any shortfall in airlift capability.

MODELING THEATER LEVEL LOGISTICS FOR WARGAMES

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The Naval War College, Wargames Department needs a computer model that simulates theater level logistics to generate wargame "ground truth" and to aid players in simple planning. Of course, a logistics model must meet a specific performance requirements in order to fill the needs of the Naval War College. This thesis presents the Surge and Sustainment Simulation, S3, a model with the required characteristics to allow the Naval War College to add logistical constraints to their wargames, both ENWGS and seminar. The relevant characteristics of the required model are defined, and the S3 model is described with a view to answering the stated requirements. Finally, an example of a Naval War College wargame run with the Surge and Sustainment Simulation is provided.

THEATER LEVEL OPERATIONS OTHER THAN WAR MODELING: APPLICATIONS OF DECISION MAKING THEORY

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This paper presents an automated model for generating courses of action in support of an Operations Other Than War (OOTW) simulation. The model simulates the decision making of a theater level staff in the OOTW humanitarian assistance mission environment. The model uses probabilistic forecasting models and Bayesian techniques to predict what the state of a region in the theater will be some time in the future. Decision tree structures and the forecasting module are used to solve the decision making problem using maximum expected utility. The model uses pairwise comparisons of utility attributes to obtain a decision maker's preference structure. This structure is applied over a multi-attribute utility function and the decision tree, to find the optimal course of action for some region of the theater at a specific time. Some variations on Lanchester's attrition equations are used to model attrition, the effect of civilians in a combat zone, and the effect of rules of engagement. The model was tested using data representative of Somalia in late 1992. The results indicated the best approach in this instance is to initially provide a high level of aid to reduce the civilian starvation rates then transition to a more aggressive posture with a strong force in readiness to retaliate for attacks by opposing forces.

U.S. NAVY'S DELAYED ENTRY PROGRAM: EFFECTS OF ITS LENGTH ON DEP LOSS AND FIRST TERM ATTRITION

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The United States Navy Recruiting Command (NAVCRUITCOM) manages the Navy's most important procurement process, the acquisition of personnel to man all Navy activities. In this process, NAVCRUITCOM policies allow potential recruits to delay their accession date for up to 365 days from the time the recruiting contract is signed through the Delayed Entry Program (DEP). One of the major disadvantages of the DEP is that an individual may decide not to enlist, becoming a "DEP Loss." This study investigates the relationship between the time an individual spends in DEP and the risk of becoming a DEP loss or leaving the service during the first two years of enlistment; log-linear regression models are discussed and recommendations are made using conditional probabilities. It was found that, on the average, DEP attrition is directly proportional to the length of DEP, while first term attrition decreases with DEP length for DEP time of eight months or less. The time an individual spends in the DEP has a larger effect on attrition during the DEP itself than it does on attrition after the contract accesses. It was also found that Non-High School Graduate males have the highest attrition proportions after completing DEP than any other group. Recommendations are provided to minimize the number of Non-High School Graduate male contracts and to reduce the length of the DEP to eight months. The results of this study will be used by NAVCRUITCOM in the development and promulgation of DEP management policies.

OPTIMIZATION MODELS FOR PLACING NURSE RECRUITERS
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This thesis addresses the problem of placing active duty nurse recruiters at recruiting stations for the United States Army Recruiting Command (USAREC). The problem can be formulated as an integer programming problem which is generally known as the incapacitated plant location problem. The objective is to maximize the yearly production of nurse commissions, a random component of the problem. To account for this random variability, Poisson regression was used to estimate the average number of commissions from a school based on distance to recruiter, nurse unemployment, local nurse salary, and number of nursing students in the graduating class. When implemented, the problem generates a large number of variables and constraints. The cpu time required to solve the problem optimally is not practical. Instead, a greedy heuristic was used. Based on several small random problems, the heuristic provides solutions within 5% of optimality on the average. To illustrate possible uses of solutions to the problem, several applications are also discussed.

AN ANALYSIS OF ECONOMIC RETENTION MODELS FOR EXCESS STOCK IN A STOCHASTIC DEMAND ENVIRONMENT
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Retention policy for U.S. Navy wholesale inventories in long supply has been in a state of flux and under Congressional scrutiny since 1985. This thesis analyzes and compares the U.S. Navy's current economic retention process to four mathematical Economic Retention Decision Models designed to assist in making retention determinations with respect of excess inventories. The motivation for this research was based on several factors, the two primary factors were; the Navy does not currently use a classical economic retention decision model when making retention/disposal decisions for "essential" material, and U.S. Navy inventories in long supply were estimated to be as high as 3.4 billion dollars in March 1993. A Pascal based simulation was developed to compare the Navy's retention process and the mathematical models. The comparison was based on performance with respect to the Measures of Effectiveness (MOE) of Total Cost and Average Customer Wait Time. The simulation was designed to emulate the portions of the Navy's consumable item inventory management system (UICP) applicable to the demand process for a Navy managed consumable item. The goal of this research was to determine how effective the Navy's retention process was as compared with economic retention decision models for both a steady state and a declining demand environment. In general, results showed that at least one mathematical model performed better than the Navy's process for all demand scenarios that were simulated and that the ideal model varies between demand scenarios and changes in decision maker's emphasis on the MOEs.

A METHODOLOGY FOR EVALUATING JOINT TASK GROUP PERFORMANCE
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The purpose of this thesis is to provide a methodology for assessing and ranking competing Joint Task Group alternatives to best provide the capabilities that fulfill the naval mission requirements of a theater Unified Commander. A notional Carrier Battle Group plus Amphibious Readiness Group, as a well understood fighting unit, is used as a benchmark in the assessment process. With decision maker participation, the methodology presented provides a logical framework which hierarchically decomposes, weights (or prioritizes), and combines the essential elements of a JTG as a warfighting "system"; its missions, Joint Mission Essential tasks, Naval Warfare areas, Mission Success Criteria, and alternative configurations, to best fulfill the needs of a particular theater. The model is readily expandable to include a greater number of mission, Joint Mission Essential Tasks, and alternatives, and may also be used in the decision-making process for selection of the multi-service Joint Task Force.

MODELING CIVILIANS AND THE CIVIL-MILITARY INTERACTION

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This study proposes a methodology for modeling civilians and their interactions with military units. The sponsor for this research, United States Special Operations Command, requested development of a model to add civil affairs, civil-military operations, and psychological operations functionalities into Joint Theater Level Simulation (JTLS). Inclusion of this capacity gives joint staff a training tool with a fuller representation of the environment currently encountered by the military. The same measures of performance cannot be used for civilian and military units, since civilians are free to waive their membership to a civilian unit. The measure of performance for a civilian unit that defines its continued existence is its well-being. Well-being is a function of the current, near term, and long term availability of items essential to civilians. Well-being is used as an index for behaviors such as generating displaced civilians, or willingness to cooperate with military forces. A psychological operations campaign directed against a community is modeled as an attempt to shift a community's perception of its well-being. Modeling civilians extends the environment currently represented in simulations to include scenarios encountered by the military in the post cold war world.

THE SMALL THEATER LEVEL MODEL: AN EXTENSION OF FTLM

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Advisor: Samuel H. Parry-Department of Operations Research

This study outlines the design, implementation, and testing of the Small Theater Level Model (STLM). The purpose of this research was the first in a sequence of efforts to determine if the course of action perception methodologies of the Future Theater Level model (FTLM) could be used in the small theater. Currently, there are no other models that have the capability to provide the small theater commander with perceptions of the enemy's intent. Additional modifications were made to FTLM in order to more accurately portray small theater operations: the addition of a range dependent attrition algorithm, high resolution of aviation assets conducting sensor observations, and the ability to provide a dynamically employable reserve force into the battle. Testing of the model was based on the development of a scenario similar to battles fought at the U.S. Army's National Training Center (NTC). Multiple replications were run, using different sensor performance standards, to evaluate the model's ability to convert reconnaissance into perceptions of the enemy's intent, and the use of a deterministic attrition algorithm in a stochastic model. A discussion of the results concludes with the requirement to conduct further testing of the course of action perception methodology, design more elaborate tactical rule sets for the employment of the reconnaissance assets and the reserve force, and ultimately, develop a more rigorous scenario that can be compared to actual NTC results.

MULTIGRID METHODS IN NETWORK OPTIMIZATION: OVERVIEW AND APPRAISAL

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Multigrid methods have been traditionally applied to the solution of certain Partial Differential Equations. However, applications in control theory, optimization, pattern recognition, computational tomography and particle physics are beginning to appear. This thesis analyzes the application of multigrid methodology to optimization problems. The work is centered on networks. Transportation problems are chosen frequently as reference because they have been the object of some multigrid research. The goal is to establish a basis for development of multi-grid based algorithms. Optimally conditions in linear programming and networks are reviewed, and a compilation of various multilevel approaches in optimization is presented. Emphasis is on the recent scaling techniques; they add some special insights into solving large network problems efficiently using progressive level of detail. An analysis of the difficulties that these problems present to the multigrid approach reveals that perhaps some abstraction is appropriate when interpreting multigrid components applied to optimization problems (in particular, the concept of grid itself). The idea of implicit ordering is developed and associated with the effectiveness of the multigrid method. These concepts are applied to identify problems that can be solved using multigrid. Finally, suggestions for the development of multigrid-based algorithms are provided.

STOCHASTIC SINGLE PERIOD INVENTORY DECISIONS: BASED ON FULL QUADRATIC COST FUNCTIONS

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This study addresses a general class of decision situations whose solutions are directly applicable to military inventory acquisitions and or disposals. Although optimal solutions are well known when subsequent costs are linear to the amount of surplus or shortage, the perhaps more realistic case of non-linear costs has not been extensively studied. The results of this study suggest the optimal solutions, i.e., acquisition quantity or supply, for both conditions of risk and uncertainty about demand when the associate cost function is non-linear and quadratic. For conditions of risk, optimal solutions are found which will yield minimum expected costs for the two-piece cost function where surplus and shortage costs are quadratic. This is done for both discrete and continuous demand variables. When future need for the item is unknown and only the maximum value can be estimated, optimal solutions are obtained for goals of minimaxing cost, minimaxing regret, and the Laplace criteria using a uniform probability distribution. Hopefully, this information will aid in the decision process while making affordability assessments of new acquisitions.

A QUANTITATIVE ANALYSIS OF FACTORS AFFECTING WEAPON SYSTEM COST GROWTH

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This thesis quantitatively analyzes the factors that affect weapon system cost growth after Milestone II. The data from nine weapon systems was reconstructed by the Army and Navy from Selected Acquisition Reports (SARs) with the cost variances reclassified into a new categorization system to more readily determine the causes of cost growth. Each cost variance was classified as to whether it was attributable to a mistake in the cost estimating process or a post-Milestone II decision, with further classification into subcategories for a more detailed analysis. The cost variances were divided by the Milestone II Decision Estimate (DE) to form a cost growth ratio (CGR). The findings reveal that the Department of Defense has about 10.8% cost growth in the procurement process. Cost growth due to decisions outweigh mistakes by a factor of 2.3:1. A majority of the mistake cost growth is due to errors in the estimation of production costs. A majority of the decision cost growth is due to schedule slippage. Low cost systems have 2.4 times as much mistake cost growth as high cost systems. Newer missile systems have significantly less mistake cost growth when compared to other systems. Lastly, the Army and Navy have approximately equal cost growth on their newer systems.

A COMPARISON AND VALIDATION OF TWO SURFACE SHIP READINESS MODELS

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Two models are used by the U.S. Navy to predict surface ship readiness: the Surface Ship Resources to Material Readiness Model (SRM) and the Surface Ship Inventory to Material Readiness Model (SIM). This thesis examines both models, in order to validate the model fit and to determine whether the two models predict significantly different levels of readiness for a given data set using both cross validation and jackknife procedures. Examination of the models reveals that there are numerous insignificant predictor variables in the models. Normality assumptions made on the non-linear regression are not proper. Additionally, the performance of both the SRM and the SIM at the ship level is poor. However, once aggregated to the fleet level, prediction performance improves drastically. Analysis of the jackknife confidence intervals indicates that the SRM and SIM predict significantly different levels of readiness. While the SIM performs slightly better than the SRM, one has to consider the marginal cost associated with the more complex SIM for model selection. Finally, use of reduced models and model modifications such as use of Poisson regression are recommended.

MODELING OPERATIONS OTHER THAN WAR: NON-COMBATANTS IN COMBAT MODELING

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This thesis describes essential modeling requirements for Operations Other Than War (OOTW). It includes discussions of the Future Theater Level Model (FTLM); a developmental combat model. This thesis also includes discussions of OOTW and a specific OOTW scenario: Operation RESTORE HOPE. This thesis proposes model attributes for non-combatants in a combat theater based on the supposition that non-combatants are an essential feature in OOTW. The model proposal includes a methodology for civilian unit decision making. The model also includes proposals for modeling attrition caused by starvation, and attrition resulting from collateral effects of combat, as well as submodels for rioting, terror attacks, and unit flight from combat. Finally, this thesis includes a numerical example of some modeling aspects in a limited scenario.

AN ANTI-AIR WARFARE STUDY FOR A SMALL SIZE NAVY

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Advisor: Wayne P. Hughes-Department of Operations Research

This thesis is a study of the defensive power of a medium size Naval force subject to air-to-surface missile attack. It evaluates the attrition to an escorted amphibious force and its escorts under different tactical situations for a variety of defense parameters. Using attrition as the measure of effectiveness, it draws conclusions useful to a small Navy regarding its AAW defenses. The study models the force-on-force process of aircraft versus warships in discrete time steps, or "salvos." The degradation of the force is expressed in ships out of action. This study extends and deepens work by W. Hughes and Lt. E. Hatzopoulos H.N., incorporating new features to analyze AAW principles and concepts.

CONTRIBUTION OF DIGITIZED COMMUNICATIONS TO THE EXTENDED CLOSE BATTLEFIELD

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This thesis develops a robust analytical computer simulation model of the Extended Close Battlefield (ECB) to examine the performance of the command, control and communications (C^3) systems of the Extended Fiber Optic Guided Missile (EFOGM), using both digitized and non-digitized communications. The ECB is represented by a 24 state Semi-Markov chain formulation. It contains transient and absorbing states that the simulation models using Monte Carlo processes and probablistic time distributions. The Primary measure of effectiveness (MOE) used for comparison between the digitized and non-digitized systems is the total time required to process a call for fire (CFF). Sensitivity analysis is performed to compare the amount of time a CFF spends in a queue, waiting to be process, within the non-digitized system over a variable range of available targets. Additional sensitivity analysis is performed by adjusting the input time parameters of the probablistic time distributions to replicate the stress of continuous combat operations. While the amount of time a CFF spends in a queue can be brought to zero for specific numbers of available targets, the digitized system outperforms the non-digitized system over all ranges of available targets, using both standard and increased values of input time parameters.

A VALIDATION STUDY OF THE KNOWLEDGE BASED LOGISTICS PLANNING SHELL USING SENSITIVITY ANALYSIS

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Master of Science in Operations Research-September 1994
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This thesis seeks to conduct a limited validation study of the Knowledge Based Logistics Planning Shell using the method of sensitivity analysis. Three parameters of the model (unit size, battle intensity, and consumer residual percentage) are varied within the context of a 2 X 3 X 3 X 3 fixed factorial model. Measurements of three measures of effectiveness: (1) Time to run demand generator, (2) Time to run distribution planner, and (3) Percentage fill of orders generated, are used as data for the study. The data is analyzed using graphical and non-parametric stastical techniques. the intuitiveness of the observed sensitivities based on their magnitude, direction and range are used to assess the validity of the data generated by this model. The Results of the study suggested a fairly high level of validity of the model's output.

A COST SIMULATION TOOL FOR ESTIMATING THE COST OF OPERATING GOVERNMENT OWNED AND OPERATED SHIPS

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The cost of operating ships is difficult to predict. A historic ship's operating cost database is maintained by the Military Sealift Command (MSC); but, it is very difficult to extract or manipulate the data to support prediction or regression analysis. An alternative was sought that would reduce the effort for the user when attempting to make predictions from the data. If the data for each cost category (salary, training, fuel, port and miscellaneous, subsistence, ship's equipage, and voyage repairs) could be well approximated using probability distributions, then the costs of an operations scenario, with estimates of the uncertainties, could be obtained through the use of a Monte Carlo simulation. The MSC data was divided into two subsets, one for model fitting and one for validation. Once probability distributions had been fit to the data, a monte Carlo simulation tool was developed using the Crystal Ball® simulation add in to Microsoft Excel®. The data analysis and cost model were then validated using the empirical data. Based on the results, the Cost Simulation model provides a useful tool for predicting operating costs and supports sensitivity analysis of various ship's operating cost scenarios.

MODELS FOR PROLIFERATION INTERDICTION RESPONSE ANALYSIS

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Master of Science in Operations Research-September 1994
Advisors: David Morton-Department of Operations Research and
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The proliferation of nuclear weapons poses a serious threat to the United States, its allies, and over-all world security. The United States seeks to dissuade or prevent new countries from acquiring nuclear weapons capabilities. This thesis constructs two models to aid decision makers in selecting strategies to interdict these proliferation efforts. The first, a "what-if" PERT/CPM model, provides an overall picture of the proliferation process. The graphical display is used to select activities to interdict, and to analyze the outcome of the choices. The second, an optimal interdiction model, selects the optimal activity(ies) for interdiction subject to risk constraints. Several runs with different numbers of interdiction points were made to test the optimal interdiction model. These results are further analyzed with the aid of the PERT/CPM model. The models, when used together, prove to be useful in selecting the optimal activities to interdict in the proliferation process.

A WHOLESALE LEVEL CONSUMABLE ITEM INVENTORY MODEL FOR NON-STATIONARY DEMAND PATTERNS

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Master of Science in Operations Research-March 1994
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The U.S. military presently manages about 88 billion dollars in spare and repair parts, consumables, and other support items. Department of Defense (DOD) inventory models which help wholesale item managers make inventory decisions concerning these items are based on the assumption that mean demand remains constant over time. In DOD this assumption is rarely met. During periods of declining demand, such as that associated with force reduction or equipment retirement, the inventory models usually keep stock levels too high, generating excess material. Recently, the amount of excess in DOD was estimated to be as high as 40 billion dollars. On the other extreme, during periods of increasing demand, the models generally provide too little stock, resulting in poor weapons system support. The purpose of this research was to develop an inventory model which does not rely on the assumption that mean demand is stationary. Use of the model would be appropriate when a known or predictable increase or decrease in mean demand is forecasted. Through simulation the model's performance was evaluated and compared with that of the Navy's Uniform Inventory Control Program (UICP) model. The results indicate that the proposed model significantly outperforms the existing model when mean demand is non-stationary. Additionally, the results indicate that the proposed model's performance is equal to or better than the existing Navy model under many stationary mean demand scenarios.

A PRODUCTION EARLY WARNING SYSTEM (PEWS) MODEL WHICH PREDICTS FUTURE USAREC MISSION ACCOMPLISHMENT

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This thesis develops a framework for a statistical Production Early Warning System (PEWS) model which predicts the United States Army Recruiting Command's contract production. Model predictions are based on the initial Armed Forces Qualification Test (AFQT) taken by applicants over the past two years, the number applicants expected to take the AFQT throughout the projection period, the historical probability that an applicant will sign a contract. Model parameters are based on the last five years of historical testing and contracting data. Yearly, seasonal, and monthly trends are incorporated by analyzing historical data using semi-monthly segments split on the 15th of the month. The model predicts contract production overall and for seven separate mission box categories. Performance of the model is measured by subtracting the number of actual contracts from the number of predicted contracts, and dividing by the number of actual contracts for FY 1993 time periods. The model's accuracy is greatly reduced because the testing data base does not include applications who took the AFQT as part of a batch test group.

COMPARISON OF THE FUTURE SCOUT VEHICLE USING THE JANUS(A) HIGH RESOLUTION COMBAT MODEL

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The purpose of this thesis is to investigate the effects of four different types of scout vehicles when performing a zone reconnaissance as part of a battalion movement-to-contact. The four different types are the current HMMWV (Highly Mobile Multi-Purpose Wheeled Vehicle), and three variants of the future scout vehicle (heavy, moderate, and light). The analysis used in the Janus(A) High Resolution Combat Model with a southwest Asia scenario. Operators at Fort Knox, KY and at the Naval Postgraduate School conducted the simulation. Six measures of effectiveness (MOE's) were used in the study. To detect any significant differences between the vehicles each alternative was compared using Scheffé's and Tukey's Methods of Multiple Comparisons. The Hierarchial Additive Weighting Method was used to rank the alternatives to determine the best vehicle suited for conducting this specific mission. The results from the data collected from both sets of operators indicate that the heavy variant of the FSV is the best vehicle for the zone reconnaissance mission.

AN ANALYSIS OF THE HISTORICAL EFFECTIVENESS OF ANTI-SHIP CRUISE MISSILES IN LITTORAL WARFARE

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This thesis examines the historical effectiveness of anti-ship cruise missiles used in littoral warfare. Missile leakage rates, probability of hit on a given target, and small combatant staying power with respect to Exocet missile equivalents are derived from historical data. These parameters are extended to modern U.S. warships displacing 7,000 tons or less, which are expected to operate in littoral waters, to determine the number of missiles needed in salvo to inflict a combat kill or sink the warship.

PLANNING GERMAN ARMY HELICOPTER MAINTENANCE AND MISSION ASSIGNMENT

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German Army light helicopter transportation regiments operate 45 Bell UH-1D helicopters to support demanding missions throughout Europe. Maintenance period scheduling, major exercise and regular mission assignment decisions directly influence the readiness of the helicopter fleet. Currently, all planning is done manually, which is unstructured and time consuming. This thesis describes a decision support system designed to assist with maintenance planning and mission assignment. The yearly maintenance and event scheduling problem and the short term mission assignment tasks are formulated and solved as elastic mixed integer linear programs. Resulting yearly schedules and short term sortie plans are both generated in a fraction of the time previously required with solution quality superior to their manual counterparts.

OPTIMIZING SAFE MOTION FOR AUTONOMOUS VEHICLES

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There are two goals for autonomous vehicle navigation planning: shortest path and safe path. These goals are often in conflict; path safety is more important. Safety of autonomous vehicle navigation is determined by the clearance between the vehicle and obstacles. Because a Voroni boundary is the set of points locally maximizing the clearance from obstacles, safety is maximized on it. Therefore, Voronoi Diagrams are suitable for motion planning of autonomous vehicles. We use the derivative of curvature κ of the vehicle motion ($d\kappa/ds$) as the only control variable for the vehicle where s is the length along the vehicle trajectory. Previous motion planning of the autonomous mobile robot Yamabico-11 at the Naval Postgraduate School used a path tracking method. Before the mission began the vehicle was given a track to follow; motion planning consisted of calculating the point on the track closest to the vehicle and calculating $d\kappa/ds$ then steering the vehicle to get onto the track. We propose a method of planning safe motions of the vehicle to calculate optimal $d\kappa/ds$ at each point directly from the information of the world without calculating the track to follow. This safe navigation algorithm is fundamentally different from path tracking using a path specification. Additionally, motion planning is simpler and faster than the path tracking method. The effectiveness of this steering function for vehicle motion control is demonstrated by algorithmic simulation and by used on the autonomous mobile robot Yamabico 11 at the Naval Postgraduate School.

AN OPTIMAL ALLOCATION OF ARMY RECRUITING STATIONS WITH ACTIVE AND RESERVE RECRUITERS

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This thesis addresses the problem of how to locate and staff recruiting stations with Active and Reserve recruiters in order to maximize the annual number of recruits. The problem is formulated as a nonlinear integer programming problem. The objective function for the problem, also referred to as the production function, describes the number of recruits obtainable from each zip code and can be estimated via Poisson regression. The resulting nonlinear integer programming problem is heuristically solved by decomposing decision variables into two sets: one to locate stations and the other to staff them with recruiters. Comparisons are made between problems with production functions derived from all zip codes and those derived from only zip codes belonging to efficient stations as defined in Data Envelopment Analysis.

REDUCTION OF COST OF THE NAVAL SPECIAL WARFARE BASIC UNDERWATER DEMOLITION/SEAL TRAINING COURSE

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Down-sizing of the military means reduction in operating budgets of most commands. Currently, the Basic Underwater Demolition/SEAL (BUD/S) training program has one of the highest attrition rates of any military school. Because of this high attrition rate there is potentially a great deal of monetary waste that could be saved in this program, both in students that do not successfully complete the program as well as those that graduate. The purpose of this study is to analyze in detail the BUD/S program, identify inefficiencies and associated potential savings and recommend future studies to expand on these savings. Topics discussed in this paper are: Determination of attrition rates and distributions for each dis-enrollment category; arrival date and its effect on graduation rate; class convening date and its effect on graduation rate; graduation potential given a student has been "rolled-back"; profile of a successful student based on service record data; recommendations for future study. It should be noted that this paper is only an initial look at the cost associated with the BUD/S attrition problem. Certain conclusions derived from the database are based on a relatively small sample that may have been affected by other factors not reflected in the database. Caution should be exercised when using the models based on small sample size.

A COMPUTER MODEL OF THE U.S. NAVY UNRESTRICTED LINE OFFICER PROMOTION PROCESS

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This thesis develops a model that accurately portrays the U.S. Navy Unrestricted Line promotion process. The pertinent aspects of the promotion process have been defined and incorporated in a personal computer based program that is capable of estimating promotion statistics over several years. The program is designed to provide the user with a framework for forecasting promotion statistics over a span of years. This framework is based on the most recent information on officer inventories, continuation rates, and Navy manpower and promotion policy. The program interface allows the user to control all of the values necessary to project promotions; permitting the examination of the effects of diverse input estimates on long term promotion statistics. Model validation was accomplished by running the model over past years promotion cycles and comparing the model results with the actual results. The model was tested using plausible assumptions about officer inventories and current manpower policy to examine the impact of the drawdown on the time it will take to promote.

US ARMY'S DELAY ENTRY PROGRAM: A SURVIVAL STUDY

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The Delayed Entry Program (DEP) has served a variety of roles in the recruiting process. In general, it acts as an inventory system of recruits which can be used to smooth out seasonal fluctuations in demand for basic and advanced individual training. It also serves to address the routine seasonal fluctuations in the recruiting process itself. DEP losses, or those individuals that renege on the agreement made with the Army to attend basic training, are a costly aspect of the program. Several studies have examined a number of aspects associated with DEP losses. When settling recruiting goals, Army analysts must consider the pool of individuals who are already in DEP. This thesis attempts to provide a method to estimate how many of those in DEP will survive to the end of the contract and enter basic training. Specifically, this thesis estimates DEP survival as a function of time spent in DEP, DEP length and other pertinent variables.

FORECASTING AIRCRAFT MISHAPS USING MONTHLY MAINTENANCE REPORTS

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Naval Aviation aircraft mishaps continue to be of great concern due to the high cost of loss of life and aircraft. The goal of this thesis is to develop a predictive statistical model that accurately forecasts Marine Corps AV-8B Harrier aircraft mishaps based on existing monthly maintenance reports. Monthly maintenance reports provide numerous independent variables based on personnel levels and maintenance hours that could possibly be used to forecast aircraft mishaps. These variables were graphically analyzed to determine any relationships that could be exploited in developing the model. Higher order relationships were investigated by the method of principal components and logistic regression. After a thorough analysis, there appears to be no combination of variables in this particular data that could be used to forecast aircraft mishaps. The overall result of the thesis is that there is no relationship between monthly maintenance reports and aircraft mishaps that can be exploited to develop a predictive statistical model.

A PROBABILISTIC MODEL FOR TARGET CLASSIFICATION AND DESCRIPTION BY TRSS SEISMIC GROUND SENSORS

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Unattended ground sensors have a tremendous potential for providing information about battlefield targets, but for the most part this potential has been unrealized. The Marine Corps has recently fielded the Phase V seismic sensors of the Tactical Remote Sensor System (TRSS). These sensors are more sensitive than any of the previous versions, and their potential to provide more detailed target information is also greater than that of previous sensors. The current target classification and description model used by TRSS was developed for sensors which were placed in use in the early 1960's. The model is simple and deterministic in nature, and does not take into account the variance in the sensor system or the variance in sensor performance due to target type, target velocity, soil composition, or other potential factors. This thesis examines the sensor system variance and the effect of target type on sensor performance through field testing and develops an improved model for target description that accounts for these effects. The revised model takes advantage of the measured sensor characteristics to better describe the target, and provides the user with bound that describe the credibility of the model's estimate.

A PROTOTYPE DECISION AID FOR ESTIMATING SALVO DAMAGE EFFECTS BASED ON A CELLULAR MODEL

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This study addresses the development of a Tactical Decision Aid to assess expected damage to a target from a salvo of warheads. It is based on a recently developed Cellular Target Concept. A secondary purpose for the development of the TDA was its potential use an investigatory tool. Previous work with cellular targets has been confined to models whose characteristics lead to simple mathematical solutions. Many target models do not lead to simple solutions. There has been some interest in observing if these models resemble the simple models asymptotically. The TDA has been designed to allow for a better understanding of how damage aggregates in these more complex models, especially when compared to the proportional damage aggregation observed in many of the simpler models. The comparisons yielded some surprising results. None of the models designed to test asymptotic proportionality appeared to show this property in the long run. Some theories are discussed in the study. The theoretical tools used to test the asymptotic behavior of the models are discussed in an appendix.

MODEL RESOLUTION TAXONOMY

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This study addresses the need for a model resolution taxonomy which allows simulation models used in military analysis to be decomposed into a common set of functional areas or dimensions, each with a corresponding measure of detail or resolution, in order to facilitate efforts to revalidate existing models for new applications, integrate existing models for new applications, integrate existing models to span broader environments, and develop variable resolution models capable of being used in a broad range of applications across varying environments. The model resolution taxonomy and an associated model resolution classification survey is developed based on interviews with subject matter experts, some with broad modeling experience, and others intimately familiar with one of a broad variety of simulation models.

DEVELOPMENT AND IMPLEMENTATION OF AIR MODULE ALGORITHMS FOR THE FUTURE THEATER LEVEL MODEL

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This thesis designs, develops, and tests three models which comprise the dynamic air route selection package for use in the Future Theater-Level Model (FTLM). Model I computes the portion of each square air grid covered by a selected characteristic radius of each ground unit. Model II uses Dynamic Programming and priority queue techniques to select ingress (and separate) egress routes from flight group air rendezvous points to a designated air grid which may be a target, reconnaissance area, or orbit location. Model III simultaneously selects a target from several candidates, selects a route and determines the implications of various escort aircraft levels in an optimal fashion, based on the measure of effectiveness (MOE) of minimizing the combined value of three factors (tactical difficulty, travel distance/time, and target priority). Comparison of different ground situations and weight sets associated with these three factors are presented to illustrate the flexibility and use of these models.

THE E-2C GROUP II UPDATE: HUMAN PERFORMANCE EFFECTS

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This study is a comprehensive analysis of the impact on operator performance resulting from the hardware and software changes incorporated in the Navy's E-2C *Hawkeye* Group II Update Development Program (UPD). Review of the available technical and operational publication produced a series of testable hypotheses concerning the impact of design changes on the navigation and communication systems, the sensors, the crew stations, and the engine and engine instruments from both a hardware and software perspective. Pilot and NFO operator duties were divided into five and six roles, respectively. Specific tasks within each role were broadly classified into one of the three categories corresponding to the type of demands they place on the operator. Four surveys were developed and used to test the hypotheses generated by the qualitative analysis, one each for pilots and NFOs for the Group II and for the baseline aircraft, the E-2C Group 0. The surveys addressed the extent to which the aircraft systems and the operator work together to produce the products of the E-2's assigned mission. The results of the survey indicate that the E-2C Group II improves operator performance by shifting workload from the operator to the system for a variety of mission tasks.

AN OPERATIONAL COMPARISON OF THE CH-46E AND HH-60H AS NAVY COMBAT SUPPORT HELICOPTER OPTIONS USING THE SIMULATED MOBILITY MODELING AND ANALYSIS TOOLBOX (SMMAT)

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This study is an operational comparison of the CH-46E and HH-60H as potential replacements for the Ch-46D combat support helicopter. The comparison is performed as a simulation using the Simulated Mobility Modeling and Analysis Toolbox (SMMAT). The model places each aircraft in a hypothetical CVBG consisting of eight ships, and has it perform a set of logistics missions. The missions are based on analysis of seven HC detachments in support of Operation Desert Storm, and consist of internal and external cargo delivery, and passenger transport. The study concludes that for the scenario modeled, the CH-46E is a more capable combat support platform, due in large part to its larger internal cargo capacity. Further study is recommended.

A CRITIQUE OF AIRCRAFT CARRIER TANK AND VOID MAINTENANCE

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Master of Science in Operations Research-September 1994
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Failure to properly maintain the tanks and voids within a ship can be one of the limiting factors of a ship's useful service life. Many problems experienced on aircraft carriers are directly attributable to inadequate maintenance of the coatings in tanks and voids. This thesis examines the current tank and void coating maintenance policy for the CVN 68 class aircraft carriers from a systems analysis perspective. It addresses the various programs and problems involved and makes specific recommendations for improvements of tank and void maintenance. Included is an analysis of current data collection and analysis initiatives, an examination of requirements under the Preventive Maintenance System, a case study on the JP-5 aviation fuel tanks, and four alternative maintenance strategies for tanks and voids.

A PROTOTYPE MODEL FOR SCHEDULING COURSES AT THE NAVAL POSTGRADUATE SCHOOL

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Master of Science in Operations Research-December 1993
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This thesis develops a prototypic integer programming model to aid in solving the Naval Postgraduate School academic course scheduling problem. The simplified model schedules faculty members to teach their assigned courses in specific rooms at specific times and schedules groups of students to the courses they have requested. The model assures, as best possible, that room capacity is not exceeded, students and faculty have time for lunch, and faculty requesting "back-to-back" courses are accommodated. To make the problem manageable, we concentrate on just one building, Glasgow Hall, and three departments, Operations Research, Mathematics and National Security Affairs. Even doing this, the model generated in GAMS (Generalized Algebraic Modeling System) has about 287,778 variables and 148,161 constraints and is too large to solve. Consequently, a simplified model, restricted to the Operations Research Department, is solved. This problem encompasses 19 faculty members, 26 courses, 83 sections and 11 classrooms. The model has less than 32,000 variables and 17,000 constraints and is solved using GAMS and the X-System on an Amdahl 8995-700A in 3488.4 seconds.

MASTER OF SCIENCE
IN
PHYSICAL OCEANOGRAPHY

DEEP CONVECTION IN THE MEDITERRANEAN SEA
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Master of Science in Physical Oceanography-September 1994
Advisor: Roland W. Garwood, Jr.-Department of Oceanography

It is now understood that deep convection in the ocean plays a dominant role in determining the climate of the world's oceans. Recent theoretical advances in explaining oceanic convection need to be tested by real observations. Satellite observations of deep convection regions may be a promising new tool in studying this phenomenon. This thesis examines deep convection events in two ways: To assess the characteristic elements of a deep convection event using two different prediction models based upon the turbulent kinetic energy budget, and to attempt to observe deep convection phenomena signals in altimeter data. In 1987, a deep convection event was observed in the northwestern Mediterranean sea (Schott and Leaman 1991). These data, combined with GEOSTAT altimeter data, were used to verify the Kraus and Turner and the Naval Postgraduate School mixed layer model predictions of the time evolution of temperature, salinity and mixed layer depth. Both models predicted final values similar to the observations, but model tuning was required to reproduce the observed rapid mixed-layer deepening. The interpolated altimeter field does not allow identification with confidence of the Mediterranean convection area. However, a locally persistent feature and the mean winter sea surface topography field agree with in-situ observations and do provide some indication about where and when the convection process occurs.

MONTEREY BAY GEOID
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A high resolution local geoid was calculated for the Monterey Bay, CA using local gravimetry data, digital elevation data and The Ohio State University OSU91A global geopotential model. The theoretical accuracy of the calculated local geoid is 3.5 cm or better over 5 km. Local gravity data came from three sources: 1,549 land observations from the Defense Mapping Agency, 179 bottom gravity observations from two Naval Postgraduate School gravity surveys of Monterey Bay and 17,098 National Geodetic Survey land and ship gravity observations from the National Geophysical Data Center's Gravity CD-ROM. Digital terrain elevation data came from the Rocky Mountain Communication Inc. 3 Arc Second Digital Terrain Elevation CD-ROM. A GPS sea surface topography experiment conducted in October, 1993, had indicated an anomalous sea slope across the bay from Santa Cruz, California to Monterey, California. Comparisons between the calculated local geoid and the regional geoid for The United States, the National Geodetic Survey's GEOID93 indicated a possible explanation for the anomalous sea slope being a local slope in the geoid.

AN INVESTIGATION OF FREQUENCY DISPERSION IN THE SHALLOW WATER WAVEGUIDE
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Master of Science in Physical Oceanography-September 1994
Advisors: Robert Bourke and James Wilson-Department of Oceanography

Sound energy in the shallow water waveguide is carried by different normal modes at different frequencies and at different depths. The sound speed profile controls the group velocity of the normal modes and can therefore cause different frequencies to travel at different speeds through the water column, this leads to frequency dispersion at a distant receiver. In some sound speed profiles there is frequency dispersion at one depth but not at another, this effect can be used to classify broadband active sonar contacts as bottom reflectors or as submarines. The effects of different types of sound speed profiles on the frequency dispersion was investigated and it was discovered that the most favorable conditions occur when there is a steep negative gradient or then there is a mixed layer. In both cases the source must be below the target depth. Computer models were used to model two shallow water environments to predict when and where advantage could be taken of the frequency dispersion effect. It was found that the effect may be robust enough to be used for 4-6 months of the year in the mid-latitudes.

A NUMERICAL STUDY OF INTERANNUAL WIND FORCING EFFECTS ON THE CALIFORNIA CURRENT SYSTEM, 1980-1983

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A high resolution, multi-level, primitive equation ocean model is used to examine the response of an idealized, flat-bottomed eastern boundary oceanic regime on a beta-plane to climatological average (1980-1989) and individual yearly (1980-1083) wind forcing. The focus of this study is the California Current System (CCS) along the coastal region, from 35° N to 47.5° N, of the Western United States. Five experiments were initialized from a state of rest and two from the fields remaining at day 360 from the climatological average wind forcing. With the climatological average wind forcing, a surface equatorward jet and poleward undercurrent are generated. Eddies form along the entire eastern boundary and a field of cyclonic eddies approximately 200 km in diameter remain at day 360. Results for the non-El Niño (1980-1981) years are very similar to the results for the climatological average wind forcing. Early in the year, the El Niño wind fields for 1983 are more intense than the average and 1989-1982 winds, and they have a much stronger poleward component. A surface poleward current develops over an equatorward undercurrent. After day 120 the winds have an equatorward component throughout the model domain, and eddies are generated, but the upwelling starts later and is weaker than in the non-El Niño years. When the 1980 winds are used to force with the fields left at day 360 from the climatological average wind forcing as initial conditions, the current and eddy system generated is more similar to CCS observations than the results of the experiments initialized from rest. Cold filaments form at the coast and extend to more than 400 km offshore. With the 1983 winds initialized from the climatological results, more poleward flow is seen at the surface early in the year. Cold filaments still develop, but later in the year and they do not extend as far offshore as in 1980. The overall current and eddy system is weaker and sea surface temperatures are warmer than in 1980. This leads to the conclusion that anomalous wind forcing is extremely important in generating CCS El Niño events.

MODELLING TOOLS FOR ACTIVE CLASSIFICATION IN SHALLOW WATER ENVIRONMENTS

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Master of Science in Applied Physics-September 1994
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Several tools have been developed, using MATLAB, for modeling the active return of a target in an arbitrary, three-dimensional ocean environment and for quantifying the environmental distortion and interference. An acoustic model based on ray theory is used to compute the target echo and reverberation. These tools have been applied to Barents Sea and Gulf of Sidra ocean environments for a billboard transmit/receive array of 25 equally spaced elements. The frequency dependence of a sonar target's echo depends on its size, shape, wall thickness, and acoustic impedance. Active classification involves using this "signature," or transfer function, to classify the target and reduce or eliminate false alarms. Complications arise due to the signal distortion that occurs in inhomogeneous ocean environments, particularly in shallow water. Multiple paths, reverberation, and ambient noise modify the received signal and make it difficult to extract the target's response. It is hoped that these tools will provide insight into the modelling and signal processing requirements for active classification as well as realistic signals for testing various schemes.

A NUMERICAL SIMULATION OF SEASONAL CIRCULATION IN THE SOUTH CHINA SEA

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The circulation in the South China Sea (SCS) is mainly determined by the monsoons. This monsoon-induced circulation is connected with the circulation in the Pacific Ocean to a small extent and linked with that of the Indian Ocean only by the Timor Current. During winter, the water enters the South China Sea at the north through Formosa and Luzon Strait, and exits at the South through Karimata Strait. During summer, the circulation reverses, the water enters at the south and exits at the north. Water from the north is generally cooler than water from the south. The northward (southward) flow induces warm (cold) advection. Therefore, the seasonal cycle of the circulation in the south China Sea becomes a major factor controlling the seasonal cycle of the sea surface temperature, which might effect the seasonal variation of the Eastern Asian monsoon system. In the preliminary results, the seasonal circulation and temperature patterns simulated by the primitive equation model are similar to those reported by Wyrtki (1961). Yet, our model is better than the Pohlmann (1987) shallow-water model and shows more details.

PREDICTION OF THE PLANE WAVE BEAMFORMED ACOUSTIC ARRIVAL STRUCTURE FOR THE 1992 BARENTS SEA COASTAL TOMOGRAPHY TEST

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Advisors: Ching-Sang Chiu-Department of Oceanography and
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In an effort to solve the forward propagation problem associated with the 1992 Barents Sea Polar Front Experiment Tomography Test, the transmission of a 224 Hz pulse signal from a near bottom sound source to a vertical hydrophone array was simulated based on three-dimensional ray theory. Through numerical raytracing, followed by eigenray searches and estimations of ray amplitudes, phases and travel times, the arrival structure as a function of time and elevation angle was constructed. The simulation was performed for both a two-dimensional and three-dimensional modeled ocean environment in order to examine the significance of three-dimensional effects. The predicted arrival structures compare well with the observed data. Three-dimensional effects proved to be significant only for the latest arrivals.

A MODAL ANALYSIS OF CURRENTS IN A PACIFIC ATOLL LAGOON

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The results of an initial quantitative study to define the physical oceanography of Johnston Atoll's lagoon circulation is presented. A bathymetric data base of the Island has been manually digitized from Navigational charts. A numerical model designed to predict the seiche modes of basins in two and three dimensions, in elliptic and cartesian coordinates is developed, which seems to represent accurately the free modes of oscillation observed in current meter records. The numerical model is suitable for applications using a personal computer equipped with MATLAB (4.0) or later, and has applicability to basins of arbitrary shape in two dimensions, and rectangular, elliptical or circular symmetry in three dimensions. An analysis of currents within the lagoon at Johnston Atoll shows highly polarized tidal flow, phase locked to the diurnal tide. Spectral energy content of current meter records show six fundamental oscillatory modes and harmonics of tidal components.

VARIABILITY OF THE CALIFORNIA CURRENT SYSTEM OFF POINT SUR, CALIFORNIA FROM APRIL 1988 TO DECEMBER 1990

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The Point Sur Transect was established in 1987 by the Department of Oceanography at the Naval Postgraduate School in order to further understand the nature of poleward flows in the California Current System (CCS). The POST extends offshore, perpendicular to bottom topography along 36^0 20'N to 123^0 01.7'W where it meets and coincides with the California Cooperative Fisheries Investigation (CalCOFI) line 67. The sampling scheme along the transect consists of 22 CTD stations and 9 PEGASUS stations and is approximately 215 km in length. POST was occupied 19 times from April 1988 to April 1991. Data from 15 of the 19 cruises were selected in order to determine the temporal and spatial variability of the CCS off Point Sur. PEGASUS data as well as hydrographic data and NOAA 11 AVHRR satellite imagery were utilized for comparison. The CUC was observed with speeds in excess of 20 cm s^{-1} throughout the year. Mean speed and depth of the CUC was 10 cm s^{-1} and 100 m respectively, 33 km offshore. The CC was found to have a semi-permanent onshore meander located 150 km offshore. Maximum speeds of this meander were in excess of 20 cm s^{-1}. Mesoscale variability was a dominant feature along POST. Meanders of the CC and the CUC, anticyclonic eddies and cyclonic eddies were all present during this study. Anomalously deep poleward flow was observed along POST. This flow appeared during all seasons with speeds in excess of 10 cm^{-1} to depths of up to 2000 m. Geostrophic velocity calculations agreed favorably with PEGASUS derived absolute velocities except during the upwelling season. Reasons for the disparity include; the selection of 1000 m as the level of no motion and surface wind stress. The variability of the CCS was determined to be interannual rather than seasonal. The short duration of this data set, when compared to earlier geostropic studies, and the absence of upper slope and shelf velocity data may account for the absence of a significant seasonal signal.

ENSO FORCED VARIATIONS OF SEA SURFACE TEMPERATURE AND SEA LEVEL ALONG THE WEST COAST OF THE UNITED STATES

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Daily coastal surface temperature and adjusted sea level data for the period 1955-1988 were used to characterize the surface temperature and adjusted sea level anomalies, and the propagation of features along the west coast of the United States during El Niño-Southern Oscillation (ENSO). The strong ENSO years examined were 1957-58, 1972-73, and 1982-83. Moderate ENSO years used were 1966, 1976, and 1987. To look at regional differences in the signals, the time series of daily coastal surface temperature and adjusted sea level were divided into three distinct regions: the southern region (i.e., Southern California), the central upwelling region (i.e., Central California), and the northern region (i.e., Northern California, Oregon, and Washington). The anomaly series were compared with cross-spectral analysis. Phase speeds and wavenumbers were estimated from the difference in phase between La Jolla and the other stations as a function of frequency band. These were used to characterize the structure of waves associated with the propagation of the positive surface temperature and adjusted sea level anomalies. These wave characteristics were found to be consistent with coastally trapped internal Kelvin waves, due to their phase speed, wavelength and non-dispersive nature. Phase speeds for frequencies corresponding to 4-20 day periods were 60-100 km/day, based on temperature and sea level. A regression of wavenumber against frequency gives phase speeds of about 65-85 km/day, that is consistent with Kelvin wave theory for typical west coast ocean structure and bathymetry. During ENSO episodes, strong warm surface temperature anomalies were found to exist along the west coast and were supported by high adjusted sea level anomalies. The use of daily observations was advantageous over traditional monthly data for this analysis.

MASTER OF SCIENCE IN PHYSICS

DIRECT TIME RESOLUTION OF SONOLUMINESCENCE

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Sonoluminescence is the synchronous emissions of pulses of light that are observed to originate from a gas bubble trapped at the pressure antinode of a resonant sound filed in a liquid. The duration of the pulse has been directly measured by launching the light through an optical fiber into a streak camera equipped with a linear array CCD detector. Questions regarding dispersion in the fiber and the fundamental limitations imposed by it are addressed. The resulting direct measurements show that the duration of the emission is less than 8 picoseconds.

THERMOSPHERIC MODELING ACCURACIES USING FORECASTED F10.7 AND AP

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This thesis analyzes the accuracy of the 45 day forecasted F10.7 and Ap values given by the Air Force Space Forecast Center. These forecasts are generated daily to aid many agencies in their fields of endeavor. The U.S. Space Command uses the values in orbit prediction routines by way of atmospheric density models. This thesis shows that the F10.7 forecasts are less accurate from one to seven days out, then deteriorate for the latter 38 days. Conversely, Ap forecasts are less accurate from one to five days out, then improve beyond the sixth day. The effects of forecasting errors upon satellite lifetimes are then shown using the Lifetime 4.1 orbital propagation model with a Jacchia '71 atmosphere. Propagating a typical satellite for 45 days over various configurations of altitudes and eccentricities showed that only a narrow altitude band from 250*km* to 325*km* is affected. Regions above or below this band are not significantly affected with errors in F10.7 or Ap.

MAGNETIC FIELD GENERATION IN SHOCK WAVES

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Laser produced plasma jets interacting with a background plasma have been used to study magnetic field generation in shock waves. Shock heating produces axial electron temperature and density gradients which are perpendicular to the radial temperature and density gradients. Electron heat transport and ion diffusion, in the radial direction, occur at different rates. This combination of non-parallel temperature and density gradients generate a magnetic field in the azimuthal direction. Simulations corroborate the experimental observation that magnetic fields are generated when a supersonic plasma jet interacts with a background plasma. Magnetic flux generated by this mechanism requires no initial field, which is in contrast to the dynamo mechanism which does require an initial seed field. Specific applications analyzed in this thesis include interplanetary shocks and nuclear EMP effects in the MHD domain. It may be assumed that shock generated magnetic fields are also of importance under astrophysical conditions.

EXPERIMENTAL HEAT EXCHANGER PERFORMANCE IN A THERMOACOUSTIC PRIME MOVER

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This thesis investigates the experimental heat exchanger performance in a neon filled thermoacoustic prime mover. The experimental approach is to measure the waveform and spectrum of the acoustic oscillations, as well as the relevant temperatures for heat exchangers of 0.257, 0.569, and 0.82 *cm* in length. A temperature gradient is established across the stack by submerging the cold heat exchanger and cold end tube in liquid nitrogen and keeping the hot heat exchanger and hot end tube at ambient temperature. Measurements are made at various mean gas pressures ranging from 1.5 to 50 *kPa* and for various effective positions of the stack in the standing wave. Acoustic pressure amplitudes as high as 29% of mean gas pressure are generated by the prime mover. The primary experimental controls over heat exchanger performance are the various heat exchanger lengths mentioned above, and the control of the thermal penetration depth, which decreases with increasing mean gas pressure. Results indicated that the prime mover can generate peak-to-peak displacement amplitudes that are much longer than the heat exchanger lengths.

X-RAY PULSE CONSIDERATIONS AND ELECTRON FLOW IN HIGH VOLTAGE VACUUM DIODES

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Electrical breakdown in high voltage diodes has been studied since the 1920s, yet it is still not well understood. This study characterizes the electron flow during breakdown in a high voltage vacuum diode. This was accomplished by measuring the x-rays produced when electrons strike the anode of the diode. Current measurements taken during the experiment include both the displacement and conduction electron current, so the x-ray signal is the best measure of the conduction current. Knowledge of the electron flow is important in determining the mechanism of breakdown. The currently accepted explosive electron emission (EE) model for electrical breakdown can not properly account for the energy required for form cathode spots. Schwirzke proposed a new model that involves an ionization process and a subsequent unipolar arc that accounts for the energy to form the spots. Electron flow for the two models is very different. The EEE model requires a large current density for several nanoseconds before plasma formation, whereas the new model predicts a large current density that develops simultaneously with the plasma formation. The results of this experiment support the predictions of the new model.

PULSE-SPLITTING AND AM-FM CONVERSION IN A NONLINEAR DISPERSIVE MEDIUM

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Experimental and theoretical results are presented for nonlinear dispersive waveguide modes in an acoustic duct. We report observations of a localized envelope which splits into two disturbances moving with two different velocities of propagation. As a consequence, we predict that if a signal is amplitude modulated at the source, spatial beating between the two disturbances will occur, and at periodic positions in space the signal will become frequency modulated. These results can have applications in an all-optical AM-FM conversion and in high data rate fiber optic communications.

A PRELIMINARY INVESTIGATION OF HIGH AMPLITUDE STANDING WAVES WITH LASER DOPPLER ANEMOMETRY

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A previous study of thermoacoustic heat transport phenomena [Atchley et al., J. Acoust. Soc. Am. **88**, 251-163 (1990)] reported measurements of the acoustically induced temperature difference ΔT generated across short, poorly thermally conducting plates situated in high amplitude acoustic standing waves. That study focused on the dependence of ΔT on the position of the plates in the standing wave, the mean gas pressure and acoustic pressure amplitude. For a given mean gas pressure, there was a threshold acoustic pressure amplitude above which irregularities appeared in the plots of ΔT vs kx. There was evidence that some velocity-dependent effect might be the cause of the discrepancies. An investigation of the acoustic velocity field in high amplitude standing waves has been initiated to determine whether there are measurable irregularities in the velocity field that can account for the observed behavior. The use of Laser Doppler Anemometry (LDA) provided accurate measurements of the velocity behavior of a gas in an empty resonator, as well as in a resonator with a crude thermoacoustic stack. Preliminary results are reported. The major conclusions are that LDA measurements of acoustic velocity fields provide reliable results and there are no significant velocity perturbations evident in our measurements. A videotape of acoustically induced flow in the resonator with a stack indicate that significant velocity perturbations do exist on time scales other than acoustic.

DESIGN, VALIDATION AND PROTOTYPE TESTING OF A HIGH RESOLUTION ALL-REFLECTION MICHELSON INTERFEROMETER FOR SOLAR OCCULTATION MEASUREMENTS OF THE OI 1304-Å TRIPLET EMISSION

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A prototype All-Reflection Michelson Interferometer (AMI) was tested using two different diffraction gradings and a variety of light sources. The original design used a focusing lens, a pinhole aperture and an off-axis parabolic mirror for collimation, a plane diffraction grating and two plane mirrors to divide and recombine the light and a CCD camera to record the interference pattern. Interference patterns were recorded and analyzed in the Interactive Data Language (IDL) using Fourier transform techniques. The design was then modified to approximate an actual instrument for remote observations of the atomic oxygen triplet emission. The results of numerous experiments using both the original and modified instruments verified the feasibility of using the AMI as a compact, lightweight, high resolution instrument for use on sounding rocket or satellite platforms.

SIMULATIONS OF AN FEL PRODUCING COHERENT X-RAYS UTILIZING THE SLAC LINAC
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Due to its tunability and high efficiency, the Free Electron Laser (FEL) has proven to be a versatile coherent light source for a variety of applications in science, industry and defense. This unique capability provides the scientific community with its first realistic source for an X-ray laser. This thesis will initially consider the basics of the FEL and its applications as a defensive weapon. In a technological era where the missile has maximized its physical capabilities to the point that defensive missiles are physically incapable of achieving a kill in protection of the fleet, speed of light weapons are the next logical step in defense. Next we shall explore the theory behind the Free Electron Laser and the amplification of a beam of light by transferring energy from an electronic beam. In conclusion, we examine the proposal to utilize the Stanford Linear Accelerator Center (SLAC) linac as an electron beam source for a high power X-ray FEL [1]. Compressing the electron pulse to a sub-picosecond length yields a peak current of 2500 amps. An electron beam energy of 7 GeV would result in a radiation wavelength of 4 nm and peak optical power in the gigawatt range. In order to examine this proposal, single-mode phase space simulations are run to look at the effectiveness of electron bunching and the onset of saturation. Longitudinal multimode simulations show coherence development and the trapped-particle instability. Transverse multimode simulations examine the effects of optical guiding and mode distortion,

A SIMPLE ANALYTICAL MODEL FOR ASYNCHRONOUS DENSE WDM/OOK SYSTEMS
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We derive the closed form expression for the bit error probability of asynchronous dense WDM systems employing an external OOK modulator. Our model is based upon a close approximation of the optical Fabry-Perot filter in the receiver as a single-pole RC filter for signals that are bandlimited to a frequency band approximately equal to one sixtieth of the Fabry-Perot filter's free spectral range. Our model can handle bit rates up to 2.5 Gb/s for a free spectral range of 3888 GHz and up to 5 Gb/s when the power penalty is 1 dB or less.

A CALIBRATION OF THE NAVAL POSTGRADUATE SCHOOL MIDDLE ULTRAVIOLET SPECTROGRAPH AND AN ANALYSIS OF THE OII 2470 Å EMISSION OBTAINED BY THE MIDDLE ULTRAVIOLET SPECTROGRAPH
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The MUSTANG, NPS middle ultraviolet spectrograph, instrument was tested using standard techniques to determine the wavelength calibration and overall sensitivity. The instrument was launched on March 10, 1994 on a NASA sounding rocket from Poker Flats, Alaska. Post-flight calibration indicates the wavelength calibration did not change as a result of the launch and no significant change in the sensitivity calibration. Ultraviolet dayglow spectra of the earth's Ionosphere from 1800 Å to 3400 Å were obtained during a similar launch on March 19, 1992 from White Sands Missile Range, New Mexico. Data were obtained on the downleg of this earlier experiment and range in altitude from 115 km to 320 km. Analysis of the data from 2420 Å to 2490 Å was conducted to obtain the intensity profile of the OII 2470.4 Å multiplet. The analysis used synthetic spectra generated for the N_2 Vegard-Kaplan and the nitric-oxide gamma band emissions.

AN ANALYSIS OF IONOSPHERIC DAYGLOW FROM OBSERVATIONS OF THE NAVAL POSTGRADUATE SCHOOL MIDDLE ULTRAVIOLET SPECTROGRAPH (MUSTANG)

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Middle ultraviolet spectra of the atmospheric airglow were obtained from a March 1992 rocket flight of the NPS MUSTANG instrument. These spectra are analyzed from 1900 Å to 3100 Å, over an altitude range of 100 km to 320 km. The data are modeled with computer generated synthetic spectra for following emissions: N2 Vegard Kaplan (VK); N2 Lyman-Birge-Hopfield (LBH); and NO Gamma (γ), Delta (δ)), and Epsilon (ϵ) bands. A best fit procedure was developed. The resulting synthetic spectra agree well with obtained airglow data. Confirmation was made of the theoretical self absorption versus non-self absorption processes of the NO (0,0), (1,0), (2,0) γ resonance band emissions. NO self absorption is a necessary inclusion of any atmospheric nitric oxide analysis stratagem. Profiles of temperature versus altitude and NO column density versus altitude for the rocket flight are estimated.

SPACE EXPERIMENTS ABOARD ROCKETS: SPEAR III

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The SPEAR III experiment was conducted in an effort to better understand and compensate for the effects of satellite charging, at levels up to 2 KV. This experiment was designed as a lower-ionosphere test to both record vehicle charging and the effect of neutral-gas grounding systems. Prelaunch tests were conducted at the NASA-Plum Brook facility; launch took place at the NASA-Wallops facility. Electrostatic analyzer data provided a record of the rocket body potential, and indications of ion production, or energy-angle scattering within the plasma sheath. Plasma wave information was extracted from floating probe data and skin current probe data. Both provided sampling to resolve signals up to 10 KHz; the skin current probe also provided burst-mode sampling up to 500 MHz. There were no obvious signals in the 0-10 KHz data, other than a diffuse, low-frequency noise. The burst-mode data, acquired at the initiation of each 5-second charging sequence, showed a strong signal at around 100 KHz. This roughly corresponds to the lower-hybrid resonance frequency. It is possible, that LHR waves are responsible for energy-angle scattering of the ion flux accelerated to the charged rocket body.

EVALUATION OF ENERGY-SINK STABILITY CRITERIA FOR DUAL-SPIN SPACECRAFT

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The nutational stability of a dual-spin, quasi-rigid, axisymmetric spacecraft containing a driven rotor is analyzed. The purpose is to examine a revised energy-sink stability theory that properly accounts for the energy contribution of the motor. An inconsistency in the development disproves the existing energy-sink theory's assumption that the motor of the system contributes exactly enough energy to offset the frictional losses between the rotor and the platform. Using the concept of core energy, the revised stability criteria for a dual-spin, quasi-rigid, axisymmetric spacecraft containing a driven rotor is derived. An expression for nutation angle as a function of core energy over time is then determined. Numerical simulations are used to verify the revised energy-sink stability theory. The dual-spin, quasi-rigid, axisymmetric system presented by D.L. Mingori was chosen for the simulation. Equations for angular momentum and total energy were necessary to validate the numerical simulation and confirm aspects of the revised energy-sink stability theory. These equations are derived from the first principles of dynamics and are included in the analysis. An explicit relationship for core energy as a function of time does not exist. Various models postulating core energy are presented and analyzed. The numerical simulations of the computed nutation angles as a function of the postulated core energy compare well with the actual nutation angles of the system to confirm the revised energy-sink stability criteria.

A TRIANGULATION METHOD FOR PASSIVE RANGING

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A method for passive ranging based on the principle of triangulation is considered. In the basic triangulation scheme, that is a single baseline model, the precision in the bearing readings can be related to the precision in the range estimation. For some target orientations the precision in the triangulated target range is completely lost. This phenomenon is known as "geometric dilution." A proposed orthogonal dual baseline scheme eliminates the "geometric dilution" effect. The performance of each of the two orthogonal baselines depends on target orientation. For specific target orientations the triangulation range measurements for the two baselines are equivalent. The dual baseline scheme would require "smart electronics" which would switch between baselines at crossover points in the range estimation precision. It is shown that the crossover points depend primarily on the ratio of the two baselines. A general expression for the maximum triangulation range consistent with limitations in minimum tolerance precision in range estimation is derived. The dependency between maximum range and target orientation are presented in polar form. Limitations in the dual baseline model due to the physical limitation created by the optical horizon are also considered.

IMAGING SONOLUMINESCENCE

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A bubble in a water/glycerine mixture trapped at the anti-node of a resonant sound field emits broadband flashes of light. Optical magnification and imaging of the light source has given insight into the spatial extent of the sonoluminescence (SL) source. This experiment shows that the SL source has a radius less than 1.5 microns.

SIMULATIONS OF THE HIGH AVERAGE POWER SELENE FREE ELECTRON LASER PROTOTYPE

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Free electron laser (FEL) technology continues to advance, providing alternative solutions to existing and potential problems. The capabilities of an FEL with respect to tunability, power and efficiency make it an attractive choice when moving into new laser utilization fields. The initial design parameters, for any new system, offer a good base to begin system simulation tests in an effort to determine the best possible design. This is a study of the Novosibirsk design which is a prototype for the proposed SELENE FEL. The design uses a three-section, low-power optical klystron followed by a single-pass, high-power radiator. This system is inherently sensitive to electron beam quality, but affords flexibility in achieving the final design. The performance of the system is studied using the initial parameters. An FEL, configured as a simple, two section optical klystron is studied to determine the basic operating characteristics of a high current FEL klystron.

TIME RESOLVED MEASUREMENTS OF LIGHT PRODUCED BY ONSET OF PLASMA FORMATION ON ELECTRODES OF FAST PULSED HIGH VOLTAGE DIODES

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Despite years of research on electrical breakdown of fast pulsed high vacuum diodes, the mechanisms of the process are far from being fully discovered. It is well known that electrical breakdown begins with plasma formation on the electrode surfaces, but there is disagreement on how this occurs. The most widely accepted model, the Explosive Electron Emission model predicts plasma formation on the cathode by means of ohmic heating caused by a field emitted current. Anode plasma formation under this model is explained as due to energy deposition by fast electrons. A new model proposes that absorbed neutral molecules on the electrode surfaces play a key role in developing the conditions where unipolar arcs cause plasma formation on both electrodes. In this work, simultaneous measurements of the light produced at the electrodes shows that plasma is produced on the anode in less than 2 nanoseconds after it is produced at the cathode. These findings support the new model.

MASTER OF SCIENCE
IN
SYSTEMS ENGINEERING

THE IR MISSILE (SPIN-SCAN AND CON-SCAN SEEKERS) COUNTERMEASURES

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In the combat scenario where the infrared missile is an almost continuous threat during the operation, fighter aircraft are currently quite susceptible to being killed in attacks by infrared missiles. Theoretical analysis applied to an encounter simulation seems to indicate that it is possible to use the infrared Active Jammer and the Expendable Decoy (flare) to defeat the infrared missile (spin-scan and con-scan seekers). The theoretical analysis of a simplified case of a spin-scan and con-scan reticle with amplitude modulation, frequency modulation and phase modulation leads to expressions for the targets' positions, as seen by the missile seeker, under no-jamming condition. The signal waveforms consist of target radiation power falling on the reticle and the reticle modulation function. We apply signal processing techniques to the modulated signal to determine the tracking error rate under no-jamming, active jamming and flare jamming different conditions, and by comparing with the unjammed tracking error rate, to determine the differences and effectiveness of jamming. The analytical result is simulated by means of a simulation program (MATLAB), which evaluates the change in the missile LOS (line of sight), rotation rate and the impact on the missile guidance operation. The analysis indicated successful jamming in the different jamming source situations. Following the jamming analysis, one can use the result to do further operational analysis as in OT&E (operation test and evaluation) and to evaluate the operational effectiveness of the jammers, and to develop operational tactics to further increase the survivability of the fighter aircraft in the combat situation.

ADVANCED COMMAND AND CONTROL WARFARE AIRCRAFT: COMMUNICATIONS COUNTERMEASURES IN SUPPORT OF AIR STRIKES

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Advisor: Randy Wight-Department of Space Systems Engineering

This thesis considers the application of Command and Control (C2) in an Integrated Air Defense System (IADS) and the utility of Command and Control Warfare (C2W), specifically communications jamming, in defeating the command and control structure of the integrated air defense system. The objective of this application of command and control warfare is to protect strike aircraft operating in hostile airspace prior to the introduction of friendly troops ashore. First, the usefulness of command and control communications is discussed as well as the value of command and control warfare. Secondly, jammer effectiveness is analyzed versus a variety of communications systems using a noise jamming mathematical analysis tool. Recommendations are made to improve the communications jamming capability for Naval and Marine Corps aviation.

OBSERVED EFFECTS OF AN ULTRA-WIDEBAND IMPULSE GENERATOR ON THE SLQ-32 (U)

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Devices capable of generating extremely short pulses of very high power with high repetition rates, yielding a frequency spectrum that is very broad (generally referred to as ultra-wideband) have been developed by Power Spectra, Incorporated, of Sunnyvale, California. These devices have several potential applications. They can be used as sources for ground and foliage penetrating radar, covert communications devices, as comm or radar jammers and as an RF weapon in an antimissile role. Additional possible applications are noncooperative target identification through airframe resonance, terrain following and simultaneous low frequency target identification. Their potential is enhanced by their small size, light weight, low power consumption and relatively low cost. This thesis reports and analyzes tests conducted at the Naval Postgraduate School in June 1994. Specifically tested were effects on the SLQ-32 Countermeasures Set, including false target generation, threat simulation and interference with a threat signal; jamming against three radar systems; and detection of the pulse generators by several other EW devices.

HARDKILL-SOFTKILL COMBINATIONS FOR OPTIMUM PROBABILITY OF KILL FOR SURFACE SHIPS (U)

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(U) One of the greatest challenges plaguing U.S. naval forces today is the threat of war in a littoral environment. Many of our combat concerns lie in territorial waters such as the Persian Gulf, North Korea, China and Haitian waters as opposed to the former U.S.S.R. forces. The AN/SLQ-32 early warning system will be analyzed to show the most effective means of utilizing Electronic Support Measures (ESM) and Electronic Counter Measures (ECM) to aid in ship's self-defense. Also, missile fire control systems, including the threat ranges of various missiles, will show how an Arleigh Burke platform performs in the probability of escaping hit (PESH) from an incoming missile. Analysis of the Arleigh Burke platform will be done to show the most effective method of utilizing its hardkill and softkill capabilities by selecting its highest probability of kill ratio. Data will be used to support the decision as to when softkill weapon systems work best alone, when hardkill weapons work best alone, and when the two systems working in tandem is the optimum solution. Recommendations will be made to existing tactical doctrines to improve present procedures.

THE AMBIGUITY FUNCTION OF THE STEPPED FREQUENCY RADAR

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Master of Science in Electrical Engineering-September 1994
Advisor: Gurnam S. Gill-Department of Electrical & Computer Engineering

High range resolution radar systems have many advantages such as target classification, resolution of multiple targets, accurate range measurement, target range profile and detection of low radar cross section (RCS) targets in clutter. High range resolution requires large bandwidths. Stepped frequency waveforms can achieve high range resolution by increasing the effective bandwidth without increasing the instantaneous bandwidth which would increase the hardware requirements including higher analog to digital (A/D) sampling rates which are limited by existing technology. Under today's hardware limitations, the stepped frequency waveform becomes very important. This thesis briefly discusses the stepped frequency radar and associated signal processing, it investigates the ambiguity function of the stepped frequency waveform and the stepped frequency radar system. Mathematical expressions of ambiguity functions are derived and the improvement of clutter suppression capability for the stepped frequency radar by rejecting initial pulses is also discussed.

PERFORMANCE OF A FAST FREQUENCY-HOPPED NONCOHERENT MFSK RECEIVER WITH NON-IDEAL NOISE NORMALIZATION COMBINING OVER RICEAN FADING CHANNELS WITH PARTIAL-BAND INTERFERENCE

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Master of Science in Systems Engineering-September 1994
Master of Science in Electrical Engineering-September 1994
Advisor: R. Clark Robertson-Department of Electrical & Computer Engineering

An error probability analysis is performed for a noncoherent M-ary orthogonal frequency-shift keying (MFSK) communication system employing fast frequency-hopped (FFH) spread spectrum. The signal is assumed to be transmitted through a frequency-nonselective, slowly fading channel with partial-band interference. The Partial-band interference is modeled as a Gaussian process. The noise-normalized receiver is employed to minimize partial-band interference effects, and the effect of inaccurate noise measurement on the ability of the noise-normalized receiver to reject partial-band interference is examined. Each diversity reception is assumed to fade independently according to the Ricean process. Thermal noise is also included in the analysis. It is found that diversity dramatically reduces the degradation due to partial-band interference, and noise measurement error does not significantly degrade receiver performance. The robustness of the receiver with regard to noise measurement error is independent of the strength of channel fading.

INBAND SCATTERING FROM ARRAYS WITH SERIES FEED NETWORKS

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Master of Science in Systems Engineering-September 1994
Advisor: David C. Jenn-Department of Electrical & Computer Engineering

Approximate formulas for the inband RCS of an array with series feed have been derived. The formulas are based on the hypothesis that an incident wave excites forward and backward traveling waves on the main line. The approximate formulas are in good agreement with results obtained using scattering matrices, thereby verifying the assumptions made in the approximate solution. Spikes in the RCS pattern have been identified with specific scattering sources in the array. The parameters affecting the level and location of the lobes have been noted. The main advantage of the approximate method relative to the scattering matrix method is at its speed. The scattering matrix method requires that a matrix equation be solved, and its size increases with the number of array elements.

INCORPORATION OF CAPTIVE-CARRY OPEN-LOOP SEEKER PARAMETERS INTO A HIL CLOSED-LOOP MODEL (U)

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B.S., United States Naval Academy, 1984
Master of Science in Systems Engineering-September 1994
Advisor: Phillip Pace-Department of Electrical & Computer Engineering

(U) Using Central Target Simulator open-loop and closed-loop simulation results, a relationship between the seeker azimuth and elevation angles and the corresponding change in missile flight profile is developed. Missile flight characteristics are extracted from hardware-in-the-loop (HIL) closed-loop runs conducted by the Effectiveness of Navy Electronic Warfare Systems (ENEWS) program in the Central Target Simulator at the Tactical Electronic Warfare Division, Naval Research Laboratory. This relationship is used to predict the missile flight dynamics associated with the open-loop (e.g., captive-carry) missile test flights. By pre-processing the open-loop seeker response, the results (including the predicted dynamics can be transitioned into a HIL closed-loop model to better evaluate the effectiveness of a shipboard Electronic Countermeasure suite. The transition pre-processor (TPP) predicts the flight dynamics of the missile using only the open-loop seeker response. The smallest prediction errors occur when the closed-loop results are used to train a set (X, Y, Z) of parametric system identification models (output error model). Results show the predicted HIL closed-loop profiles closely match the true flight profiles within 10-20 feet.

MODIFICATION OF THE NAVAL POSTGRADUATE SCHOOL LIDAR SYSTEM

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The Naval Postgraduate School (NPS) Lidar System was modified to allow comparison of lidar profiles with radiosonde profiles preparatory to evaluation of the lidar as a monitor for changes in the boundary layer. The detector package was modified to permit day and night operation and to reduce the overlap-limited minimum measurement range. Redesign of the transmitter beam expansion optics raised the power threshold for internal optics damage while improving the filling the 18" output mirror and maintaining eye safe operation. Tests of the system on completion of modification demonstrated clear-air returns to ranges of 1 to 1.5 kilometers. Direct comparison of clear-air lidar returns with radiosonde balloon launches can now be undertaken to evaluate correlation of changes.

VERIFICATION OF THE RADAR RANGE EQUATION AND ITS VARIANTS IN THE AFIC IMOM COMPUTER MODEL AND RECOMMENDATIONS FOR MODELING CW AND COHERENT PULSE RADARS IN THE CURRENT AFIC IMOM COMPUTER MODEL

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Advisors: Frederic H. Levien-Electronic Warfare Academic Group and
Gurnam S. Gill-Department of Electrical & Computer Engineering

This thesis verifies the radar range equation, and its variants, which appear on the AFIC computer program Improved Many (Jammers)-on-Many (Radars), IMOM. The IMOM computer program is employed operationally by the U.S. Air Force to model the electronic order of battle for use by their pilots in the mission planning of strike missions. IMOM allows the mission planner to evaluate electronic combat effects through computer color graphics display of the electronic order of battle, including terrain effects. First, it will be shown that the radar range equation agrees with radar theory. Next, the manner in which the radar range equation is modified to account for stand-off jamming is examined. Once these two areas have been examined, these equations are further verified by substituting typical values into these equations, and comparing these results with results calculated by IMOM. Particular attention is paid to the IMOM program's current method of modeling coherent pulse and CW radars. The theory of modeling these types of radars is examined and recommendations on the modeling of CW and coherent pulse radars are discussed.

A NEED TO CALIBRATE INDICATOR FOR HIGH FREQUENCY DIRECTION FINDING SYSTEMS

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This thesis proposes and investigates a new approach in attacking the "need to calibrate" problem of the shipboard HFDF systems. It is based on measuring the system response to multiple onboard near-field sources are stored in a reference database. Whenever a modification is made to the topside, the near-field test is repeated and the new results are compared to the near-field reference database. A significant difference may indicate a need to perform a full system calibration. The calibration procedure was simulated using the numerical electromagnetics code PATCH. Calculations show that the antenna responses for near and far-field sources are comparable when topside changes were introduced.

AIRBORNE INFRARED DETECTION OF THEATER BALLISTIC MISSILES AND CUEING OF THE AEGIS RADAR IN SPACE AND ELECTRONIC WARFARE ENVIRONMENT (U)

Robert B. Powers-Lieutenant, United States Naval Reserve
B.S., Virginia Tech, 1986
Master of Science in Systems Engineering-December 1993
Advisor: Joseph Sternberg-Department of Physics

This study is a systems analysis of a tactical scenario involving an airborne platform working together with an Aegis surface ship to destroy a theater ballistic missile in flight. An Infrared Search and Track (IRST) system on the airborne platform will enable it to detect and track a ballistic missile in flight. After generating sufficient information to characterize the trajectory of the missile, cueing information would be passed to the Aegis platform. Based on this cue from a source external to the ship, the SPY-1 radar on the Aegis would acquire and track the ballistic missile with a minimum amount of diversion from its primary Anti-Air Warfare role. Cueing will make earlier radar acquisition for an interceptor missile possible, thus expanding the defended area around the ship. Trajectories for five different ballistic missiles are analyzed in the context of the tactical scenario. Based on analysis of trajectories from the viewpoint of the infrared sensor, a missile range discrimination technique is developed that cues the Aegis radar with a missile launch range error estimate. This infrared sensor missile range estimate is then correlated to Aegis radar acquisition ranges via its magnitude relative to Aegis radar search volumes.

SCAN-TO-SCAN CORRELATION FOR PHALANX SURFACE SEARCH MODE USING MODIFIED OPTIMAL GATING

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Advisor: Phillip E. Pace-Department of Electrical & Computer Engineering

Phalanx Close-in Weapons System is a fast reaction, rapid-fire computer controlled radar and gun system designed to effectively engage anti-shipping missiles and fixed wing aircraft at short range and high velocity. In the current signal processing, low velocity surface targets are excluded by a highpass digital moving target indicator (DMTI) clutter filter. These low velocity targets can enter a ship's self defense zone undetected and pose a serious threat to naval combatants. Hence, the needs exists to incorporate a *surface search mode* that engages these low velocity targets. This thesis is a follow-on study to LT David B. Brewer's thesis [Ref. 3] that instruments a signal processor allowing for the detection of slow moving targets. This thesis develops a scan-to-scan correlation algorithm using a *Modified Optimal Rectangular Gating* (MORG) technique. It analyzes the output from the DFT filter bank search signal processor. The MORG algorithm correlates detections from numerous scans and efficiently establishes which detections are true targets, while filtering out sea-clutter. The correlation algorithm is evaluated using actual recorded sea-clutter data from a Phalanx system with non-calibrated fluctuating targets inserted.

ELECTRONIC COMBAT HARDWARE-IN-THE-LOOP TESTING IN AN OPEN AIR ENVIRONMENT

Ronald Keith Stepp
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Master of Science in Systems Engineering-September 1994
Advisor: D. Jenn-Department of Electrical & Computer Engineering

Although the development process for electronic warfare systems includes hardware-in-the-loop testing and open air range flight testing, it does not specify the need to conduct hardware-in-the-loop testing in an open air facility. This thesis evaluates the usefulness of open air hardware-in-the-loop testing. This evaluation is based upon the comparison of the facilities, this thesis presents feedback from three sources who have hardware-in-the-loop test experience at both indoor and outdoor facilities. Based on the research conducted, the conclusion of this thesis is that the established electronic combat test process should be formally modified to include open air hardware-in-the-loop testing.

MITIGATION OF EMI GENERATED BY A VARIABLE-FREQUENCY-DRIVE CONTROLLER FOR AN AC INDUCTION MOTOR

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Master of Science in Systems Engineering-September 1994
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In recent years a significant number of digital devices and systems have been added to receiving and data-processing sites. These additions have enhanced the ability of the sites to accomplish their mission. These additions have enhanced the ability of the sites to accomplish their mission. They have also introduced new kinds of electromagnetic interference (EMI) into these sites along with accompanying performance degradation problems. In this thesis one specific case of EMI is considered. It is EMI from a digital climate-control system of a building housing a data-processing facility. The digital system generated excessive amounts of EMI. The EMI was conducted throughout the site over power and control conductors. Electromagnetic fields from EMI current flowing in these conductors coupled the EMI into other nearby conductors. Integrated barrier, filter, and ground techniques were used to reduce the conducted and radiated EMI to harmless levels.

MASTER OF SCIENCE
IN
SYSTEMS TECHNOLOGY

AN ANALYSIS OF C^{4}I EFFECTIVENESS USING THE RESA WARGAME

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B.S., United States Naval Academy, 1987
Master of Science in Systems Technology-June 1994
and
Temijuiin H. Glass-Lieutenant, United States Navy
B.S., University of Utah, 1986
Master of Science in Systems Technology-September 1994
Advisor: Samual Parry-Department of Operations Research

This thesis describes qualitative and quantitative analyses of the tactical effects of differing levels of command, control, communications, computers, and intelligence (C^{4}I). The RESA wargame at the Naval Postgraduate School was utilized in an experiment with 24 United States Naval Officers. The thesis begins with an introduction of the importance of C^{4}I and then discusses several aspects of wargames. The experimental plan (with corresponding appendices) covers all aspects of the actual experiment, including scenario description, conduct of each simulation run, and data collection. Analyses are performed on the data utilizing graphs and statistical printouts. A mean value differential analysis is also performed for additional clarification of results. Offensive and defensive results are discussed with respect to the two factors of warfare specialty and information level. Both factors did affect offensive performance. Players from the TACAIR community were able to place a greater percentage of ordinance on target. Additionally, as information level increased, the total number, as well as percentage of strike aircraft reaching the target increased up to the final level, in which a slight decrease was observed. However, neither of the two factors had an effect on defensive performance. The thesis concludes with the authors' opinions as to any results which were contrary to those anticipated, as well as recommendations for follow-on study and lessons learned.

A MODEL FOR BATTLE DAMAGE ASSESSMENT IN COMMAND AND CONTROL WARFARE

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B.S., Temple University, 1990
Master of Science in Systems Technology-December 1994
and
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B.S., Chapman College, 1985
Master of Science in Systems Technology-June 1994
Advisor: Carl R. Jones-Department of Systems Management

The main thrust of this thesis is to build a dynamic model of a Command and Control (C^2) system and, by manipulating various aspects of the model, determine the effects of Command and Control Warfare (C^{2}W) on the system. The model used is a prototype for battle damage assessment in C^{2}W. A description of how the model was constructed, discussions of the decisions concerning what to model and of the difficulties and deficiencies associated with the model is also included. Commercial off the shelf software, called Design/CPN and Workflow Analyzer, manufactured by Meta Software, is used to construct the model of a JTF information handling system in a hostile environment. The basis for this model is an Integrated Computer Aided Manufacturing Definition (IDEFO) functional flow diagram of the same system.

SPREAD SPECTRUM APPLICATIONS IN UNMANNED AERIAL VEHICLES

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Master of Science in Systems Technology-June 1994
Advisor: Michael K. Shields-Department of Electrical and Computer Engineering

This thesis is part of an ongoing Naval Postgraduate School research project to develop unmanned aerial vehicles (UAVs) using current off the shelf (COTS) technology. This thesis specifically evaluated a spread spectrum UHF data link between a UAV and ground terminal. The command and control (C^2) process and its role as the fundamental premise of the warfare commander were discussed. A review of the Pioneer Remotely Piloted Vehicle (RPV), which gained such wide recognition during Operations Desert Storm and Desert Shield, was provided to the reader for familiarization with the workings of a generic UAV. An investigation of two common spread spectrum techniques and there associated benefits was made. A link budget calculation was made. The choice of a spread spectrum radio transceiver was reviewed. The requirements and design of the UAV and ground terminal antennae were discussed. A link budget analysis was performed. An atmospheric path propagation prediction was performed. The details of an actual flight test and the data gathered were examined. Future changes to enhance the data link performance and increase its capabilities were introduced. The COTS spread spectrum data link will enhance the role of the UAV in its command and control mission for the warfare commander.

U.S. NAVY SHF SATCOM: PAST, PRESENT AND FUTURE

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Master of Science in Systems Technology-June 1994
Advisor: Dan C. Boger-Department of Systems Management

This thesis discusses the Navy's Super High Frequency Satellite Communications (SHF SATCOM) capabilities prior to Desert Shield, Desert Storm, and the requirements for future systems that were generated due to Navy SATCOM shortcomings during the Gulf War. The four-phased evolutionary approach the Navy has designed (based on post-war requirements) to provide itself with a medium for SHT SATCOM into the 21st Century, as well as the Defense Satellite Communications Systems (DSCS), are examined in detail. Decreasing defense budgets have begun to have a significant impact on future military satellite communication (MILSATCOM) systems. A cost comparison between utilization of DSCS III satellites and the INMARSAT commercial SATCOM system is presented. Recommended improvements to current MILSATCOM procedures and training practices are proposed that could improve operational C^4I capabilities. Finally, this study determines that future SATCOM architectures should include a mixture of commercial systems and MILSATCOM systems to provide both cost savings and command and control protection.

VIDEOCONFERENCING AND ITS ROLE IN THE ARMY

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B.S., Georgia Southern University, 1985
Master of Science in Systems Technology-June 1994
Advisor: Carl R. Jones-Department of Systems Management

This thesis discusses the capabilities and the requirements for integrating videoconferencing technology into the Army's communication system. As the bandwidth requirements for videoconferencing are lowered and the bandwidth availability increases, it is becoming more feasible to incorporate a videoconferencing system into a commander's communication structure. The current family of videoconferencing equipment is reviewed and current standards that govern videoconferencing are examined. Videoconferencing systems are described in both a tactical and garrison environment with an emphasis on bandwidth requirements, survivability, and system security. Also, current tactical examples of videoconferencing use are discussed to provide insight as to the possible future uses of systems. Currently videoconferencing systems are used for staff planning, videomedicine, and videotraining. Finally, a projected videoconferencing architecture for a corps/division is analyzed with possible locations of the videoconferencing sites and communication systems that could link videoconferencing sites together. A breakdown of possible users is provided to show that videoconferencing can play a successful support role in the Army.

PERSONAL COMMUNICATIONS SERVICES: IMPROVING THEATER DEPLOYABLE COMMUNICATIONS FOR THE 21ST CENTURY

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Personal Communications Services (PCS) may be the key ingredient for vastly improved military communications capabilities at the turn of the century. The Federal Communications Commission (FCC) defines PCS as "a family of mobile or portable radio communications services which could provide services to individuals and businesses and be integrated with a variety of competing networks...the primary focus of PCS will be to meet communications requirements of people on the move". Today's generation of Theater Deployable Communications (TDC), which provides joint tactical communications to deployed forces, is the Tri-Service Tactical Communications (TRI-TAC) system. A description of TRI-TAC's family of equipment, network topology, typical employment, and critical limitations is presented in this thesis. Five commercial Mobile Satellite Services (MSS) are described as viable candidates for augmenting existing communications systems. Cellular design principles such as frequency reuse, cell splitting, channel access methods, and propagation factors are also addressed. Finally, a framework for comparison of the candidate MSS systems is proposed as a baseline for further studies into the most beneficial implementation of PCS into theater deployable communications systems for the future.

ON STUDYING THE EFFECT OF INFORMATION WARFARE ON C2 DECISION MAKING

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B.S., University of Florida, 1987
M.B.A., University of Dayton, 1991
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Advisors: Carl R. Jones and Kishore Sengupta-Department of Systems Management

The goal of practitioners of information warfare is always concerned with affecting the decisions made by the enemy. With a clear understanding of how the enemy makes decisions, it is easier to target the processes which are involved in making those decisions. The purpose of this thesis is to demonstrate whether information warfare, when directed at a command and control decision maker, can be administered in quantified amounts which can be used to change what would normally be a good tactical decision into a bad one. This thesis uses a software package called Tactical Tic-Tac-Toe (T4), to simulate command and control decisions being made in an information warfare environment. The three measures of effectiveness of winning battles, winning missions (aggregate battles), and increasing one's won-to-loss ration are used to evaluate the quality of the decisions being made. Fog of War, Tactical Delay, Area Delay, and Communications Delays are combined to determine their effects on command and control under these measures of effectiveness. Clearly the data shows that delaying one's immediate opponent from grasping the tactical picture serves to greatly enhance the chances of increasing one's effectiveness. Further, delaying the enemy's understanding of "pieces" of the strategic picture (which might not be viewed as immediately tactically important), also dramatically increases effectiveness.

DEVELOPMENT OF THE COMMUNCATIONS SYSTEM FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

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B.S., University of Floridia, 1988
and
David B. Weiding-Lieutenant, United States Navy
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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Rudy Panholzer-Space Systems Academic Group

The payload and primary function of the Petite Amateur Navy Satellite (PANSAT) will consist of a Direct Sequence Spread Spectrum (DSSS) communications system. System development began with the initiation of various analog designs by thesis students. Development has since changed to a digital design based on research done by a Space Systems Academic Group technician. This thesis documents the development process of the communications system, primarily focusing on the change from an analog design approach to the current digital approach.

AN ANALYTICAL COMPARISON OF SPACED BASED MARITIME SURVEILLANCE TECHNIQUES(U)

Greg L. George-Lieutenant Commander, United States Navy
B.A., University of Missouri, 1979
and
Daryl R. Haegley-Lieutenant, United States Navy
B.S., University of South Carolina, 1987
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Phillip A. Durkee-Department of Meteorology

Research indicates that distinct curvilinear cloud feature - shiptracks - form as ships transit areas dominated by low altitude stratus clouds, cool temperatures and high humidity. These shiptracks are evident in NOAA satellite visible/infrared spectrum imagery. This thesis compares imagery from NOAA satellites against selected non-imagery surveillance data to determine the level of correspondence in ship geolocation between these sources. The primary purpose of this comparison is to assist in determining the utility of employing NOAA imagery in detecting, localizing, and tracking ships transiting areas obscured by clouds which preclude direct observation. Low correlation rates resulting from the comparative analysis indicate that NOAA imagery reveals a significant number of ships which might otherwise go undetected. Full operational utilization of this imagery provides cost effective detection and localization of surface vessels under weather conditions which degrade other surveillance sensors. The imagery analyzed in this thesis is presently avaialable to deployed Carrier Battle Groups and Marine Amphibious Forces via currently fielded processing equipment and communcations pathways. Exploitation of existing NOAA AVHRR imagery for maritime surveillance by Naval/Marine forces requires no additional investment in new hardware or software and only minimal on-site training.

AN ANALYSIS OF C^{4}I EFFECTIVENESS USING THE RESA WARGAME

Temijuiin H. Glass-Lieutenant, United States Navy
B.S., University of Utah, 1986
Master of Science in Systems Technology-September 1994
and
David J. Adams-Lieutenant, United States Navy
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Master of Science in Systems Technology-June 1994
Advisor: Samual Parry-Department of Operations Research

This thesis describes qualitative and quantitative analyses of the tactical effects of differing levels of command, control, communications, computers, and intelligence (C^{4}I). The RESA wargame at the Naval Postgraduate School was utilized in an experiment with 24 United States Naval Officers. The thesis begins with an introduction of the importance of C^{4}I and then discusses several aspects of wargames. The experimental plan (with corresponding appendices) covers all aspects of the actual experiment, including scenario description, conduct of each simulation run, and data collection. Analyses are performed on the data utilizing graphs and statistical printouts. A mean value differential analysis is also performed for additional clarification of results. Offensive and defensive results are discussed with respect to the two factors of warfare specialty and information level. Both factors did affect offensive performance. Players from the TACAIR community were able to place a greater percentage of ordinance on target. Additionally, as information level increased, the total number, as well as percentage of strike aircraft reaching the target increased up to the final level, in which a slight decrease was observed. However, neither of the two factors had an effect on defensive performance. The thesis concludes with the authors' opinions as to any results which were contrary to those anticipated, as well as recommendations for follow-on study and lessons learned.

PERFORMANCE EVALUATION OF GROUND BASED RADAR SYSTEMS

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Master of Science in Systems Technology-June 1994
Advisor: Frederic Levien-Department of Electrical and Computer Engineering

Ground based radar systems are a critical resource to the command, control and communications system. This thesis provides the tools and methods to better understand the actual performance of an operational ground based radar system. This thesis defines two measurable performance standards: 1) the baseline performance, which is based on the sensor's internal characteristics and 2) the theoretical performance, which considers not only the sensor's internal characteristics, but also the effects of the surrounding terrain and atmosphere on the sensor's performance. The baseline radar system performance, often used by operators, contractors, and radar modeling software to determine the expected system performance, is a simplistic and unrealistic means to predict actual radar system performance. The theoretical radar system performance is more complex; but, the results are much more indicative of the actual performance of an operational radar system. The AN/UPS-1 at the Naval Postgraduate School was used as the system under test to illustrate the baseline and theoretical radar system performance. The terrain effects are shown by performing a multipath study and producing coverage diagrams. The key variables used to construct the multipath study and coverage diagrams are discussed in detail. The atmospheric effects are illustrated by using the Integrated Refractive Effects Prediction System (IREPS) and the Engineer's Refractive Effects Prediction System (EREPS) software tools to produce Propagations Conditions Summaries and Coverage Displays. Atmospheric data (radiosonde), collected in May 1991 from the same location as the An/UPS-1 system under test, was used with the IREPS and EREPS software to illustrate the impact of the atmosphere on the ground based radar system's performance. Any reasonably accurate prediction of ground based sensor system performance must consider the effects of the installed environment, as discussed in this thesis.

THE EFFECTIVENESS OF TACTICAL ADAPTION AND COORDINATION TRAINING ON TEAM PERFORMANCE IN TACTICAL SCENARIOS

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Master of Science in Systems Technology-June 1994
Advisor: Michael G. Sovereign-Joint C3 Academic Group

In Command and Control, decisions require the fusion of inputs from a number of subordinate decision-makers during the situation assessment process. The tactical operating environment often introduces stress into the team's decision-making process. The Office of Naval Technology in Arlington VA has sponsored research under the Tactical Decision-Making Under Stress (TADMUS) program to study ways to minimize the degradation to the teams' effectiveness during these periods. Under the TADMUS Project, the Tactical Adaption and Coordination Training (TACT) experiment was designed by Alphatech, INC. to test theories on individual and team training techniques that were hypothesized to mitigate the effects of stress during tactical situations of interest (high and low stress scenarios). In a detailed review of the data gathered during the experiment, it is concluded that the training strategies were indeed effective in significantly altering the subject teams ability to perform under the test conditions. Additionally, there were no conclusive findings that the level of stress, as presented in the experiment, had a significant effect on the performance of the teams.

A TACTICAL IMPACT STUDY OF A NATIONAL SYSTEM (U)

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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Herschel H. Loomis-Department of Electrical & Computer Engineering

This thesis is an investigation into the tactical impact of a national system's ability to provide information in a timely and useful manner about targets of Naval interest.

AN ANALYTICAL COMPARISON OF SPACED BASED MARITIME SURVEILLANCE TECHNIQUES (U)

Daryl R. Haegley-Lieutenant, United States Navy
B.S., University of South Carolina, 1987
and
Greg L. George-Lieutenant, United States Navy
B.A., University of Missouri, 1979
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Phillip A. Durkee-Department of Meteorology

Research indicates that distinct curvilinear cloud feature - shiptracks - form as ships transit areas dominated by low altitude stratus clouds, cool temperatures and high humidity. These shiptracks are evident in NOAA satellite visible/infrared spectrum imagery. This thesis compares imagery from NOAA satellites against selected non-imagery surveillance data to determine the level of correspondence in ship geolocation between these sources. The primary purpose of this comparison is to assist in determining the utility of employing NOAA imagery in detecting, localizing, and tracking ships transiting areas obscured by clouds which preclude direct observation. Low correlation rates resulting from the comparative analysis indicate that NOAA imagery reveals a significant number of ships which might otherwise go undetected. Full operational utilization of this imagery provides cost effective detection and localization of surface vessels under weather conditions which degrade other surveillance sensors. The imagery analyzed in this thesis is presently avaialable to deployed Carrier Battle Groups and Marine Amphibious Forces via currently fielded processing equipment and communcations pathways. Exploitation of existing NOAA AVHRR imagery for maritime surveillance by Naval/Marine forces requires no additional investment in new hardware or software and only minimal on-site training.

SURVEY OF UNITED STATES COMMERCIAL SATELLITES IN GEOSYNCHRONOUS EARTH ORBIT

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B.S.E.E.T., Florida A&M University, 1987
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Dan C. Boger-Department of Systems Management

This thesis examines the domestic commercial satellite options available for telecommunication and remote sensing services. The study provides a single source, comprehensive examination of the available commercial U.S. geosynchronous telecommunications satellites as well as the remote sensing spacecraft which may be utilized for commercial purposes. A general satellite communications technology overview is provided as background material for the more detailed satellite compendium. The following telecommunications operators are included with their respective domestic communications satellites: Alascom, Alpha Lyracom Pan American, AT&T, Comsat, GE Americom, GTE Spacenet, Hughes and Intelsat. Satellite evolution, overview, key design features, and performance parameters are catalogued. Additionally, each satellite's communications payload is examined in detail. Emerging technologies in the remote sensing field are presented. The current GOES and NOAA satellite systems are surveyed with an emphasis on each satellite's capabilities and operational status.

JOINT COMMAND, CONTROL AND COMMUNICATIONS: AN ARMY PERSPECTIVE

Daniel R. Kestle-Captain, United States Army
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Master of Science in Systems Technology-June 1994
Advisor: Carl R. Jones-Department of Systems Management

This thesis discusses the Army's structure, communications architecture, communications system and equipment, and communications-electronics role in the Joint Task Force. It provides readers an understanding of current Army systems and frames requirements for their evolution. The intended audience is other than Army. Accordingly Army structural and communications parochialisms are described. After establishing a baseline of Army structure and communications, a discussion of the Unified Command command and control architecture ensues. The Joint Task Force and separate Service communications responsibilities are then delineated. Discussions on joint communications interoperability and existing trends are included. Trends of note are the increase in reliance on satellite communications and bandwidth requirements in support of bulk data transmission. The running themes throughout this thesis are doctrine and technology. These are two of the primary drivers for future communications architectures. Thus there is a focus on the current status of joint doctrine and existing communications equipment in the Army inventory. To highlight future Army systems requirements, a scenario is described.

THE DESIGN AND IMPLEMENTATION OF THE MILITARY APPLICATIONS OF SHIPTRACKS EXPERIMENT ON SPACE TRANSPORTATION SYSTEM - 65

Andrew R. Kirschbaum-Lieutenant, United States Navy
B.S., United States Merchant Marine Academy, 1987
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Philip A. Durkee-Department of Meteorology

A detailed discussion is presented on the design, documentation, participants, mission conduct, and payload support involved in the MAST experiment onboard the STS-65 mission. A comparison is shown between the high resolution imagery obtained from the MAST experiment and current weather imagery from NOAA satellites. Recommendations are made for further MAST payloads on future Space Shuttle flights.

EXPLOITATION OF CELLULAR COMMUNICATIONS(U)

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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Herschel H. Loomis-Department of Electrical & Computer Engineering

Cellular telephones have become embedded in the communications infrastructure throughout the world. Communication uses range from supplements to the standard, wired infrastructure in technologically advanced countries to a quick, easy, cost-effective means of fulfilling basic needs in the Third World. There are many different analog cellular systems on the market and new, technically advanced digital systems have just recently been fielded. This paper begins with background information on cellular history and theory. Then an in-depth investigation of the basic technology involved in any cellular system is presented. Topics include hardware features and electronic characteristics. Additionally, the signal propagation aspect and limitations of cellar signals are studies. A description of specific analog and digital systems and the countries in which they are fielded gives a general feel for the magnitude of cellular users throughout the world. The remainder of this paper focuses on the intelligence applcations of cellular systems.

A MODEL OF PRE-REQUIREMENTS SPECIFICATION (PRE-RS) TRACEABILITY IN THE DEPARTMENT OF DEFENSE

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Master of Science in Systems Technology-September 1994
and
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Master of Science in Systems Technology-June 1994
Advisor: Balasubramaniam Ramesh-Department of Systems Management

The purpose of this thesis is to explore the current DoD initial system development process and develop a model of Pre-Requirement Specification (pre-RS) traceability. The model is based on a comprehensive study of stakeholder needs during development of large scale, software intensive systems. The motivation for this research is that current DoD standards require traceability and these standards do not specify what information should be captured. A field study of nine independent DoD organizations involved in initial systems development was conducted to determine how traceability is used to ascertain the information needs of various stakeholders. The model developed in this research provides a basis for formulating guidelines on implementing Pre-RS traceability in DoD.

SATELLITE SUPPORT TO SEA-BASED THEATER BALLISTIC MISSILE DEFENSE(U)

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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Herschel Loomis-Department of Electrical & Computer Engineering

The purpose of this thesis is to investigate and quantify the utility of Space-Based cuing for Sea-Based Theater Ballistic Missile Defense (SB-TBMD). Utilizing a Cramer-Rao Closed Loop Monte-Carlo program, error ellipsoids are generated for a variety of theater ballistic missile range classes based on the capabilities of various existing and developmental space systems. these error baskets are presented graphically and in numerical form at 10 second intervals along the calculated true trajectory. Detection ranges are determined based on the known capabilities of the AEGIS weapons System to investigate a volume of space at given range using a specific operating mode. The AEGIS radar is evaluated in both its current configuration and with various hardwar and software upgrades. A classified simulation program attempts to validate the resultant ranges using the error data generated by the Cramer-Rao Progarm to modify the capabilities of a generic radar model. The final result of the thesis is a quantification of the value-added nature (characterized by increased detection ranges and number of engagements) of space-based cuing. In addition, a recommenation is made regarding the system or system parameters that prove most beneficial in the cueing of an AEGIS platform for TBMD.

A HYBRID ENHANCEMENT TO PRECISION GEOLOCATION CAPABILITIES (U)
Michael P. Lipscomb-Lieutenant, United States Navy
B.S., Western Washington University, 1984
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Herschel H. Loomis-Department of Electrical & Computer Engineering

The current SIGINT reconnaissance force structure is aging. Most of the system designed orginated in the late 1960's, were designed as tools of the "Cold War" to prosecute specific type of analog signals. These systems have contributed critical mission intelligence information, and effectively addressed the requirements for which they were designed to satisfy. With the collapse of the Iron Curtain, the international political environment is somewhat unpredictable and the U.S. intelligence lelments are challenged to provide responsive support to both the nation and tactical users. A rapid growth in digital personal communication technology using cellular and LPD/LPI techniques is challenging the intercept effectiveness of the National systems. To meet the future intelligence requirements, a transition of current fielded capabilities to highly modular open system architectures needs to be done. This paper examines the factors and means to enchance the SIGINT collection and precision geolocation capabilities against the digital signals associated with the technologically advanced commercial and military command and control (C2) communication systems in use. A review of RF protection methods, personal communication network trends, geolocation methods, and capabilities of the National systems are provided.

A FRAMEWORK FOR APPLYING ASYNCHRONOUS TRANSFER MODE (ATM) TECHNOLOGY TO COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS
Carolynn A. Luce-Lieutenant, United States Navy
B.A., University of Rochester, 1988
Master of Science in Systems Technology-June 1994
Advisors: Carl R. Jones and Myung W. Suh-Department of Systems Management

Asychronous Transfer Mode (ATM) has a great promise for supporting band-width intensive, delay-sensitive requirements that well be typical of future command, control and communications (C3) systems. There are many factors to be considered in implementing ATM in a C3 system, making this a complex decision process. Since information technology decisions by their nature are inherently complicated, the use of a framework helps to structure this decision problem. In the context of systems engineering, the author introduces a decision framework for applying ATM in C3 systems and choosing among alternatives. An overview of C3 and an introduction to ATM technology, including current implementation issues, provides the reader with basic concepts. A brief review of alternative and competing technologies is covered to provide a baseline for comparison with ATM. The decision framework is developed using trade-off, risk, performance and cost analyses. Scenarios and network architectures form the alternatives considered in the framework. The Analytic Hierarchy Process (AHP) is used in the framework to synthesize the results of the analyses and helps to select a preferred network architecture.

NATIONAL SUPPORT TO TOMAHAWK STRIKE PLANNING (U)
Rodney E. Malloy-Lieutenant, United States Navy
B.A., University of San Diego, 1987
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Co-Advisors: Dan C. Boger and Carl R. Jones-Department of Systems Management

The purpose of the thesis is to examine the value added of using a Direct Down Link (DDL) architecture for national overhead systems in support of planning Tomahawk cruise missile missions at sea. The current dissemination system does not facilitate a timely receipt of national products to mission planner afloat. The paper also examines national products which have not been previously used in support of Tomahawk mission planning. A concept of operations for the use of the Tomahawk Weapons System will be proposed taking into account the collection, processing and dissemination of the national level data in support of Tomahawk land attack missions. The technical feasibility of the Direct Down Link is examined using link budget and data flow analysis. The focus of the thesis will be a systematic view of this proposed architecture.

IMPLICATIONS OF CDMS CELLULAR ON CRYPTOLOGY (U)

Gary R. Melvin-Lieutenant, United States Navy
B.S., University of Missouri-Columbia, 1988
Master of Science in Systems Technology-September 1994
Advisor: Paul Moose-Command, Control and Communications Academic Group

Code division multiple access (CDMS) is a digital modulation technique which has been shown to provide substantial bandwidth capacity gains for the cellular phone industry. It may also provide a high degree of communications security as compared to current cellular systems. This thesis lays the groundwork to assess the impact of such a system by describing the fundamentals of spread spectrum technology and its application as a multiple access technique with emphasis on its low probability of intercept property. Further, an introduction to a proposed CDMA cellular communications system is provided. Lastly, an introduction to spread spectrum detection theory is described. Other real world factors are given to complete the initial impact assessment of a CDMA cellular phone system on the intelligence community.

A SURVEY OF COMMERCIALLY AVAILABLE EXPENDABLE HEAVY LIFT LAUNCH VEHICLES

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B.S.M.E., Villanova University, 1986
Master of Science in Systems Technology-June 1994
Advisor: Dan C. Boger-Department of Systems Management

This thesis examines the launch vehicle options available to place a heavy payload, 10 tons, into a low-earth-orbit. The study provides the current status of the space launch vehicle market for heavy lift launchers. The following launchers are looked at in detail: Titan 3, Proton, Energia, Long March 3, Ariane 5, and the H-2. Vehicle design history and launch record are examined. Each launcher is then examined and broken down by stages, including the payload sections. A typical launch sequence is included for each vehicle. Finally, the cost of the various launchers is examined. Conclusions regarding the future need of heavy lift launch vehicles and a look at the current political environment is made.

SURVEY OF UNITED STATES COMMERCIAL SATELLITES IN GEOSYNCHRONOUS EARTH ORBIT

Jeffrey L. Miller-Lieutenant, United States Navy
B.S.E.E.T., Florida A&M University, 1987
and
Lawrence D. Hunt-Lieutenant, United States Navy
B.S., University of Massachusetts, 1984
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Dan C. Boger-Department of Systems Management

This thesis examines the domestic commercial satellite options available for telecommunication and remote sensing services. The study provides a single source, comprehensive examination of the available commercial U.S. geosynchronous telecommunications satellites as well as the remote sensing spacecraft which may be utilized for commercial purposes. A general satellite communications technology overview is provided as background material for the more detailed satellite compendium. The following telecommunications operators are included with their respective domestic communications satellites: Alascom, Alpha Lyracom Pan American, AT&T, Comsat, GE Americom, GTE Spacenet, Hughes and Intelsat. Satellite evolution, overview, key design features, and performance parameters are catalogued. Additionally, each satellite's communications payload is examined in detail. Emerging technologies in the remote sensing field are presented. The current GOES and NOAA satellite systems are surveyed with an emphasis on each satellite's capabilities and operational status.

THE CURRENT STATUS OF CIS/RUSSIAN COMMUNICATION SATELLITES

Larry E. Ninas-Lieutenant Commander, United States Navy
B.S., Auburn University, 1983
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Randy Wight-Department of Electrical and Computer Engineering

As part of a Memorandum of Understanding (MOU) signed by U.S. President George Bush and Russian President Mikhail Gorbachev during a July 1991 summit meeting, the U.S. agreed to expand civil space cooperation with the Russian Federation and the Commonwealth of Independent States (CIS). The goal of the MOU was "to increase the technical capabilities of both sides to respond to both natural and man-made disasters" and "to benefit from the capabilities and involvement of international and non-government organisations." This summit agreement has allowed the Russian Federation to offer unprecedented commercial and emergency relief access to their on-orbit communication satellites. This thesis present a brief history of the Soviet/Russian communication satellite program, and an examination of current systems as well as future and "on order" systems. Simulations were conducted to determine the useability of the major systems (Gorizont, Ekran, Molniya, and Raduga) from 16 geographic locations. This thesis concludes with an introduction to the Telemedicine Spacebridge Project that is a direct result of the Bush-Gorbachev summit and is a shining example of Russian/U.S. cooperation in the satellite communication arena.

RADAR OBSERVATIONS OF FIELD-ALIGNED PLASMA PROPAGATIONS ASSOCIATED WITH NASA'S PMG EXPERIMENT

Darren M. Olson-Lieutenant, United States Navy
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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Richard C. Olsen-Department of Physics

NASA's Plasma Motor Generator (PMG) tethered satellite mission was launched in June 1993 to verify the ability of hollow cathode plasma sources to couple electric currents from a electrodynamic tether into the ambient ionospheric plasma. This large-scale coupling process resulted in turbulent plasma signatures associated with the orbiting plasma generator, which propagated over great distances along the earth's geomagnetic field lines. VHG radars in Hilo, Hawaii and Jicamarca, Peru recorded observations of these field-aligned disturbances as part of the experiment. Based on analysis of these radar observations and tracking data of PMG's orbit, the effective propagation of velocity of these traveling plasma waveforms was calculated to be of the order of 1000 meters per second. Detection of these disturbances, associated with PMG's passage overhead, supports the existence of a phantom current loop allowing current flow along the magnetic field lines of the earth and into the lower ionosphere from either end of an electrodynamic tether.

A PROCEDURE FOR ACCESSING DIGITAL SATELLITES CONTAINING AMATEUR PAYLOADS

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B.S., Marquette University, 1986
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: I.M. Ross-Department of Aeronautics and Astronautics

The Space Systems Academic Group's (SSAG's) Amateur Radio Station User's Guide and an embedded user-friendly menu interaction system comprise the scope and purpose of this thesis. The User's Guide was developed in an effort to identify the best procedures to use when accessing amateur radio frequencies. Although the Amateur Radio Station is capable of voice and continuous wave (CW) communications, these areas are not addressed within the context of this manual. This manual is dedicated to the processes involved in accessing digital satellites containing amateur payloads. Most of the information found in this user's manual was obtained from existing sources. This manual attempts to organize that information, and demonstrate how it applies specifically to the SSAG Amateur Radio Station.

A MODEL FOR BATTLE DAMAGE ASSESSMENT IN COMMAND AND CONTROL WARFARE

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B.S., Chapman College, 1985
Master of Science in Systems Technology-June 1994
and
Fedora M.H. Baquer-Lieutenant Commander, United States Navy
B.S., Temple University, 1990
Master of Science in Systems Technology-December 1994
Advisor: Carl R. Jones-Department of Systems Management

The main thrust of this thesis is to build a dynamic model of a Command and Control (C^2) system and, by manipulating various aspects of the model, determine the effects of Command and Control Warfare (C^2W) on the system. The model used is a prototype for battle damage assessment in C^2W. A description of how the model was constructed, discussions of the decisions concerning what to model and of the difficulties and deficiencies associated with the model is also included. Commercial off the shelf software, called Design/CPN and Workflow Analyzer, manufactured by Meta Software, is used to construct the model of a JTF information handling system in a hostile environment. The basis for this model is an Integrated Computer Aided Manufacturing Definition (IDEFO) functional flow diagram of the same system.

LESSON LEARNED FROM EXPERIMENTS CONDUCTED ON RADAR DATA MANAGEMENT SYSTEMS

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B.S., College of Great Falls, 1985
Master of Science in Systems Technology-June 1994
Advisor: William G. Kemple-Department of Operations Research

The thesis provides lessons learned from experiments conducted by the 11th Air Force to verify the capabilities of two vendor-produced Radar Data Management Systems (RDMS). The first part of the thesis provides background information explaining the impetus for such experiments and why a lessons learned approach was taken. The experimental plan and the final report from the PACAF experiments are analyzed using evaluation tools taught in the C3 curriculum at the Naval Postgraduate School. The lessons learned from the mistakes made during these experiments are applied to produce a revised Experimental Plan. A lessons learned section follows the analysis. This section discusses specific lessons learned by the author. The thesis concludes with two chapters that provide overall conclusions and a summary, and recommendations for future work that can be accomplished in the area of radar data management.

A SYSTEMS ANALYSIS AND PROJECT MANAGEMENT PLAN FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: I. Michael Ross-Department of Aeronautics and Astronautics

The Petite Amateur Navy Satellite (PANSAT) is a communications satellite being developed at the Naval Postgraduate School by the Space Systems Academic Group. This thesis is the result of an investigation into all aspects of the project. Research, analyses, and recommendations were concentrated in the areas of engineering design, testing, orbital operations, and organization and management. The study identified the upcoming Shuttle to Mir flights as providing the most attractive orbital parameters for PANSAT operations. A systems analysis was conducted that attempted to develop and prioritize engineering design issues requiring more thorough investigation. The chief problem area discovered by this analysis was in the power production aspect of the Electrical Power System (EPS). PANSAT was determined to have a negative power margine under certain conditions, and an even lower power margin than previously believed under most conditions. It is recommended that the project make satellite development its principal objective (over education) to maximize the likelihood of success. Student participation in the project is the single greatest asset of the project, and it remains largely untapped. Re-organizing the project to increase student involvement, within the constraints of the Space Systems curricula, will improve efficiency by easing extraneous requirements on an overtasked engineering staff, and thereby improve overall productivity.

A LAYMAN'S LOOK AT ORBITAL DEBRIS

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B.S., United States Military Academy, 1984
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Kyle T. Alfriend-Space Systems Academic Group

Artificial space debris is a new and threatening reality. This thesis examines the requirement of acknowledging this threat as one of the major considerations in the design of Low Earth Orbit (LEO) satellites. The paper commences with a comprehensive view of the issue; the facts of the case are presented. It is necessary to understand the physical fundamentals of this multi-faceted problem in order to view it as a genuine threat to satellites. Following this introduction, an overview of how the problem is currently approached, from a political and technical standpoint, is discussed. Strategies for coping with the space debris issue are then presented. From these, the paper focuses on the most promising prospect for the future. It highlights the need for new and resonsible satellite design philosophies in order to deal with the uncertainties of the LEO environment. The research effort concludes that space debris considerations must be incorporated at the earliest phases of a satellite's design efforts and must be a continuing commitment throughout the operational life of a satellite.

COMMAND AND CONTROL IN OPERATIONS OTHER THAN WAR: A NEW FRAMEWORK

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B.S., United States Naval Academy, 1987
Master of Science in National Security Affairs-June 1994
Master of Science in Systems Technology-June 1994
Advisors: Carl R. Jones-Department of Systems Management and
Dana P. Eyre-Department of National Security Affairs

The author presents a new framework for approaching command and control in operations other than war (OOTW). Currently, no common doctrine exists, between potential coalition partners to guide the command and control process in this particular environment. As a consequence, coalitions are formed ad-hoc, which has potential consequences for the adequacy of the resulting command and control process and system, and commensurately, for the speed and impact a coalition may have in a target environment. The author examines current US perceptions concerning command and control, intelligence, and communications, and conceptual adjustments required of US forces due to the nature of the irregular environment. Challenges and lessons learned from recent OOTW are then discussed in order to identify, to the degree possible, the specific impediments to optimum coalition command and control. Conclusions stress that a common and standardized approach is required to blend the political agendas, capabilities, and limitations of a diverse coalition into an efficient and effective entity. To accomplish this, the approach must include a methodical and iterative process which logically, chronologically, and holistically frames and links the problem at hand, the resources arrayed to address the problem, and the functions that comprise the problem solving process, in a manner appropriate to existing conditions at any particular time. The COordination, COoperation, and COnsensus (CO^3) Loop presented in this thesis makes an initial effort at providing the common approach required.

BEACON TECHNOLOGY AND WORLDWIDE TRACKING APPLICATIONS VIA LOW-EARTH ORBITING SATELLITE SYSTEMS (U)

James John Shaw-Lieutenant Commander, United States Navy
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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Dan C. Boger-Department of Systems Management

This thesis discusses beacon technology, current and future system architectures and applications in worldwide data collection and tracking endeavors. Recent technical developments, including the miniaturization of electronics and Global Positioning System (GPS) navigation receivers as well as the deployment of low-Earth orbiting communication satellites, have made possible the fusion of low-power beacons with accurate geolocation capabilities. Future beacon progams and architectures will be driven by technology and worldwide remote data and high resolution tracking requirements. Running themes throughout this thesis are technology and application. These are two of the primary drivers for future beacon programs and architectures.

A MODEL OF PRE-REQUIREMENTS SPECIFICATION (PRE-RS) TRACEABILITY IN THE DEPARTMENT OF DEFENSE

Jeffrey S. Spearman-Lieutenant, United States Navy
B.S., Southern Illinois University, 1987
Master of Science in Systems Technology-June 1994
and
Robert C. Laubengayer-Lieutenant, United States Navy
B.S., United States Merchant Marine Academy, 1986
Master of Science in Systems Technology-September 1994
Advisor: Balasubramaniam Ramesh-Department of Systems Management

The purpose of this thesis is to explore the current DoD initial system development process and develop a model of Pre-Requirement Specification (pre-RS) traceability. The model is based on a comprehensive study of stakeholder needs during development of large scale, software intensive systems. The motivation for this research is that current DoD standards require traceability and these standards do not specify what information should be captured. A field study of nine independent DoD organizations involved in initial systems development was conducted to determine how traceability is used to ascertain the information needs of various stakeholders. The model developed in this research provides a basis for formulating guidelines on implementing Pre-RS traceability in DoD.

SOFTWARE TESTING TOOLKIT FOR DISTRIBUTED SIMULATIONS

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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisors: Gary Porter-Command, Control and Communications Academic Group and
Michael Macedonia-Department of Computer Science

This thesis discusses the need for and design of a software toolkit to monitor Distributed Interactive Simulation (DIS) network performance. Plans to merge virtual environment and wargaming simulations into combined exercises will have significant performance effects on existing networks, but the tools to quantify the impact are lacking. Given the need for performance measurement tools, the network environment is described and two software development methods, Motif and Tcl/Tk, are considered. The merits of Tcl/Tk, including extensibility to access DIS networks and ease of application development, resulted in a programming environment well-suited for this requirement. The network toolkit design is presented, including the required modifications to Tc/Tk. Areas for future research include using the PDU Monitor and the Tcl/Tk applications, and expanding their capabilities.

GPS AND THE S-3 VIKING: ENHANCING COMBAT EFFECTIVENESS (U)

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Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Dan C. Boger-Department of Systems Management

The NAVSTAR Global Positioning System will soon be the navigational standard for all U.S. military forces. All DoD aircraft will be equipped with GPS by October 1, 2000. New applications of GPS are being developed, including using GPS as the basis for precision weapons guidance and establishment of a common tactical reference grid. In order to understand the issues surrounding the integration and exploitation of GPS by the S-3 community, there must be a thorough understanding of how the system operates and how it can be employed. This thesis provides a quick education on the Global Positioning Systems and how it works. The potential enhancement to S-3 combat effectiveness is presented by taking a conceptual look at how GPS can be employed in various warfare areas. A discussion of integration issues is followed by recommendations for the early establishments of requirements.

DEVELOPMENT OF THE COMMUNICATIONS SYSTEM FOR THE PETITE AMATEUR NAVY SATELLITE (PANSAT)

David B. Weiding-Lieutenant, United States Navy
B.A., University of Washington, 1987
and
Michael P. Finnegan-Lieutenant, United States Navy
B.S., University of Floridia, 1988
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Rudy Panholzer-Space Systems Academic Group

The payload and primary function of the Petite Amateur Navy Satellite (PANSAT) will consist of a Direct Sequence Spread Spectrum (DSSS) communications system. System development began with the initiation of various analog designs by thesis students. Development has since changed to a digital design based on research done by a Space Systems Academic Group technician. This thesis documents the development process of the communications system, primarily focusing on the change from an analog design approach to the current digital approach.

THE FUTURE USE OF DSCS AND COMMERCIAL SATELLITES IN THE U.S. NAVY

Robert J. Zoppa-Captain, United States Army
B.S., United States Military Academy, 1987
Master of Science in Systems Technology (Space Systems Operations)-September 1994
Advisor: Dan C. Boger-Department of Systems Management

This thesis considers the Navy's use of the Defense Satellite Communcations System (DSCS), International Maritime Satellite (INMARSAT) network, and the International Telecommunications Satellite (INTELSAT) system with emphasis on the future utilization of C, X, and Ku-band Super High Frequency (SHF) communications in the Navy's satellite communications (SATCOM) architecture. It evaluates all three systems addressing critical issues such as anti-jamming capability, survivability, timeliness, availability, interoperability, and capacity. All three satellite systems currently have a place in the Navy's SATCOM architecture. This thesis focuses on the advantages and disadvantages that the DSCS satellite network offers the Navy and recommends using DSCS for low capacity protected circuits and high capacity unprotected service in the future. Additionally, a recommendatio is made for a future high capacity DSCS follow-on satellite. This thesis also addresses the advantages and disadvantages that INMARSAT and INTELSAT offer the Navy and recommends that these systems be used as surge communication mediums in the future.

ADVISOR INDEX

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